

AMERICAN JOURNAL OF ORTHODONTICS

OFFICIAL PUBLICATION OF
THE AMERICAN ASSOCIATION OF ORTHODONTISTS,
ITS COMPONENT SOCIETIES, AND
THE AMERICAN BOARD OF ORTHODONTICS

Editor in Chief

H. C. POLLOCK, ST. LOUIS, MO.

Sectional Editors

CHARLES R. BAKER, Evanston, Ill.

HENRY COSSITT, Toledo, Ohio

JOSEPH D. EBY, New York City

WILLIAM E. FLESHER, Oklahoma City, Okla.

HENRY F. HOFFMAN, Denver, Colo.

STEPHEN C. HOPKINS, Washington, D. C.

JAMES D. McCOY, Beverly Hills, Calif.

OREN A. OLIVER, Nashville, Tenn.

Associate Editors

DENTISTRY FOR CHILDREN

WALTER T. McFALL, Asheville, N. C.

ABSTRACTS AND REVIEWS

J. A. SALZMANN, New York City

PUBLISHED BY THE C. V. MOSBY COMPANY, ST. LOUIS 3, U. S. A.

TABLE OF CONTENTS ON PAGE 2

Copyright 1952 by The C. V. Mosby Company

Vol. 38

MAY, 1952

No. 5

**You save time and work
and avoid trouble...**



SPECIFICATIONS

MATERIAL

Platinum-colored, non-oxidizing precious metal alloy, strong yet pliable.

GAUGE

33B&S (.007")

WIDTH

.180" (approx. 3/16")

DIAMETERS

No. 1—.360"	No. 7—.450"
No. 2—.380"	No. 8—.460"
No. 3—.400"	No. 9—.470"
No. 4—.420"	No. 10—.480"
No. 5—.430"	No. 11—.490"
No. 6—.440"	No. 12—.500"

These DEEORTHO one-piece bands are great time and work savers because they eliminate the cutting and soldering of band material. They save material too, because you have no left over ends. They avoid trouble, because there's no seam to open up when soldering tubes to the bands.

DEEORTHO Seamless Bands come in the 12 different diameters listed at left and shown full size above. Among them you'll find a size to fit practically any molar. Try DEEORTHO Seamless Bands. We're confident you will be pleased with their convenience and economy. Your dealer can supply them.

OTHER DEE ORTHODONTIC PRODUCTS

Deeortho Band Materials • Dee Lock Wire • Deeortho Buccal Tubes
Deeortho Half-Round Tubes • Deeep Wire



HANDY & HARMAN

DEE PRODUCTS GENERAL OFFICES & PLANT
1900 WEST KINZIE STREET • CHICAGO 22, ILL.
TORONTO 2B, ONTARIO, 141 JOHN ST. • LOS ANGELES 63, CALIF., 3625 MEDFORD ST.

Baker GENUINE JOHNSON MATERIALS AND INSTRUMENTS



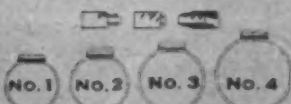
IMPROVED JOHNSON LOCK



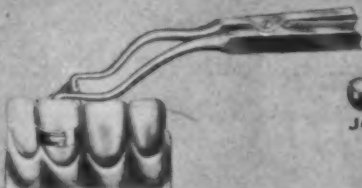
LOCK SEATING AND
REMOVING PLIERS



LOCK PLACING PLIERS



ANTERIOR PINCH BANDS



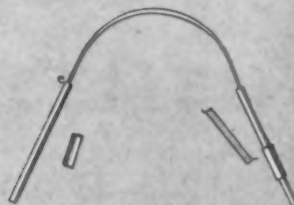
ANTERIOR BAND FORMING PLIERS



COIL SPRING MANDRELS & CHUCK



JOHNSON VISE



STAINLESS STEEL TWIN
WIRE ARCH ORALIUM
TUBES 1/4" X .036 SPRING
STEEL COIL, .009 WIRE



LOOP MOLAR BANDS

THERE is both safety and pleasure in using genuine proven Johnson Twin Arch materials carrying the inventor's approval and the guarantee of the Baker name.

Locks are mounted on 4 sizes of Platin-alloy pinch bands, 1/4" and 3/8" wide, either with or without ligature holes. The present caps have just the right amount of friction.

You need stock only 4 sizes of the Oralium or Platinaloy molar loop bands.

Don't be fooled into buying makeshift wire and tubing. We have 1/4 and 1/2 lb. spools of all sizes specially hard-drawn spring wire and soft ligature wire. Our carefully made genuine Johnson laminated arch tubing .023 I.D. x .035 O.D. costs a few cents more, but does not bend in the mouth after soldering.

Let us send you a Johnson outfit complete with instruments, reprints of the technique and catalogue of our entire orthodontic line. Be sure to give us your dealer's name.



BAKER & CO., INC.
113 Astor St., Newark, N. J.

30 Church St.
New York

55 E. Washington St.
Chicago

760 Market St.
San Francisco



CONTENTS FOR MAY, 1952

American Journal of Orthodontics

Original Articles

- Aims, Aids, and Auxiliaries. Francis J. Loughlin, D.D.S., Jamaica, New York City, N. Y. ----- 315
- The Physiologic Basis of Relapse. George W. Huckaba, B.A., D.D.S., Memphis, Tenn. ----- 335
- Certain Factors of Aberration to Be Considered in Clinical Roentgenographic Cephalometry. Jacob B. Franklin, D.D.S., Milwaukee, Wis. ----- 351
- Twenty-five Years' Experience With the Zygomatic Method. H. Berger, Dr. Med. Dent., Tel-Aviv, Israel ----- 369

In Memoriam

- George R. Moore ----- 382

Orthodontic Abstracts and Reviews

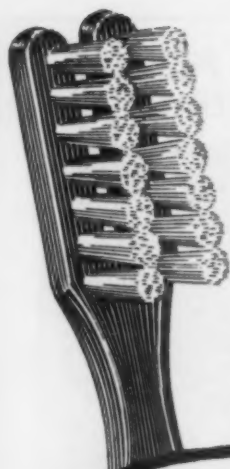
- Orthodontic Abstracts and Reviews ----- 384

News and Notes

- News and Notes ----- 395

Officers of Orthodontic Societies

- Officers of Orthodontic Societies ----- 398

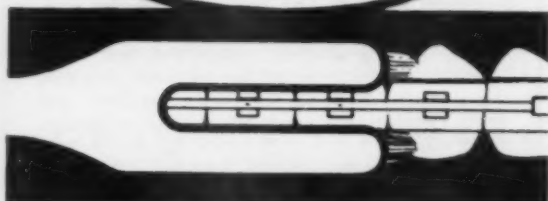


Longer, flexible
fine bristles
soft to gum tissue

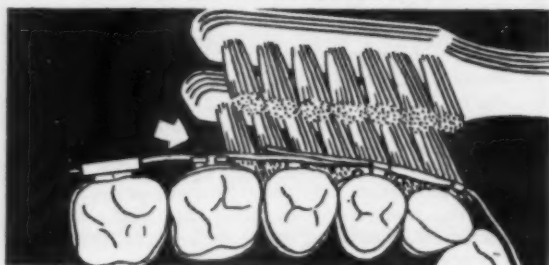
THE
NEW

BI-PO

DUAL ACTION



Cleanses the cervical areas
without interference



Gets in, around and under
appliance structure

Many orthodontists are starting
their patients with BI-PO with
noticeably improved oral hygiene.
Also available in short bristles.

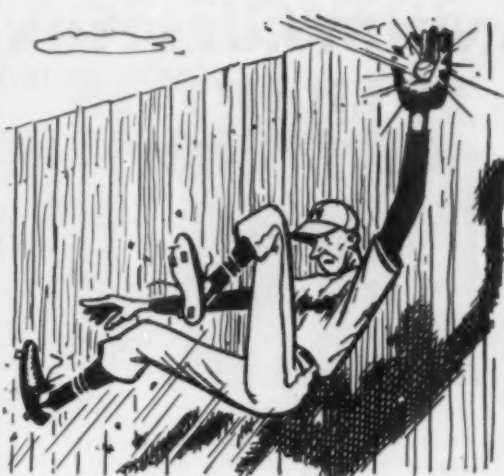
Free sample on request

BI-PO COMPANY
or UNITEK CORP.

Box 737, Palo Alto, Calif.
275 W. Halstead Avenue,
Pasadena, Calif.

© 1952

LOOK FOR THE BI-PO DUAL BRUSH-HEAD



GRAB AND HOLD

Once more the voice of the umpire is heard in the land—and the base hits are rattling against the outfield fence. Our own hero, however, is the glue-gloved ball hawk who foils the slugers by grabbing hot ones right off the wall. The way he grabs hold of and hangs on to the ball reminds us (here it comes) of the way S-C Cement grabs hold of and hangs on to appliances. The only difference is that S-C Cement holds on to what it grabs for keeps!

We think S-C will make a hit with you. Try it at our expense. For a free sample, mail the coupon in your professional envelope.

S-C CEMENT



A FREE BOOKLET that gives "The Low-Down on a High Quality Dental Cement" is available. If you would like a copy of this informative publication, check the attached coupon.

STRATFORD-COOKSON COMPANY

4058 Haverford Avenue, Phila. 4, Pa.

Please send me the following, without any charge or obligation:

☐ S-C CEMENT Sample

☐ CEMENT Booklet

Dr. _____

Address _____

PSYCHOSOMATICS AND SUGGESTION THERAPY IN DENTISTRY

\$3.75

By DR. J. STOLZENBERG

Author and Lecturer on Psychosomatics
and Hypnosis in Dentistry

"One of the best on the subject yet to appear"
—*Journal of Dental Medicine*, July, 1951

*"This book should be in every Dentist's library;
the only book of its kind."*—*The Psychiatric
Quarterly*, July, 1951

*"Dentists and Dental Hygienists who have little
knowledge of this subject will find this book of
incalculable interest and value."*—*N. Y. State
Dental Journal*.

A Partial List of the Contents:

- Psychological Management of Patients
- How to Approach the Apprehensive Patient
- How to Overcome Bruxism and Teeth-Clenching and other Psychosomatic Manifestations During Orthodontic Treatment
- How to Break Oral Habits Contributing to Malocclusion
- Conditioning of Patients to Overcome Gagging when Taking Impressions, Taking X-Rays and Wearing Removable Appliances
- How to Employ Hypnosis in Dentistry

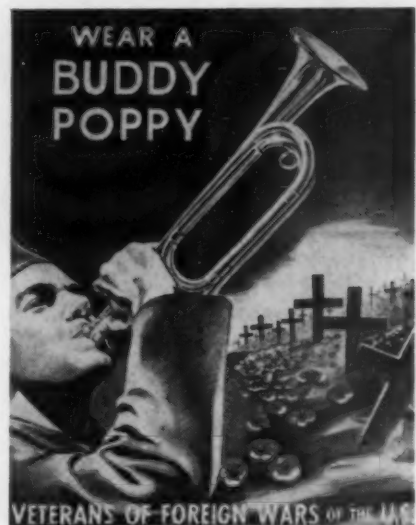
Send Check With Your Order Today!

LEO L. BRUDER

1 DeKalb Avenue

Brooklyn 1, N. Y.

BUDDY POPPY PROCEEDS USED FOR SERVICE



The V.F.W. Buddy Poppies, made by men, disabled and needy, who served our nation in its Armed Forces, symbolize not alone America's tribute to the heroic dead, but also the grateful wish to help those veterans and their families who may be in need of assistance today.

Disbursements of the annual sale proceeds are strictly confined to the following purposes: relief of disabled and needy veterans, their dependents, or their widows and orphans; maintenance or expansion of the V.F.W. National Home for widows and orphans of veterans; hospital or individual assistance and entertainment for needy veterans and service patients, and their dependents; rehabilitation, welfare, and service work, including liaison service with the Veterans Administration; military funerals of deceased veterans, burial plots and decoration of graves of veterans and service men; and to compensate the hospitalized veterans who make the Buddy Poppies.

In each community, nearly 70 per cent of the total Buddy Poppy receipts are used for local veteran welfare and rehabilitation. The Veterans of Foreign Wars is primarily an organization dedicated to serving disabled and needy comrades, no matter in what war they fought or whether or not they are V.F.W. members. The only requisites needed to obtain V.F.W. assistance are that they served our country honorably and that their claims for aid are worthy.

The V.F.W. was the first veterans' organization to conduct the poppy sale movement on a nation-wide scale in 1922, using French poppies made by women and children of the devastated areas. The present Buddy Poppy plan, developed in 1924, is recognized by the U. S. Veterans Administration as a valuable adjunct to their Occupational Therapy. Each Buddy Poppy is guaranteed by a copyrighted green label.

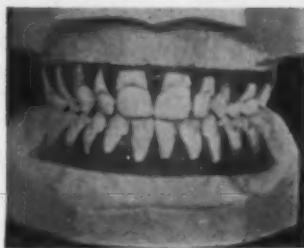
Acrycett

ORTHODONTIC POSITIONERS

AN AID TO DENTO-FACIAL-ORTHOPEDICS



I. After bands are removed.



II. "set-up" by Acrycett from which appliance is constructed.



III. Appliance in position.

An Approved Appliance to Assure Your Cases an Esthetic, Functional and Successful Completion

Acrycett Positioners are constructed of a flexible, non-toxic plastic especially compounded for Acrycett. Labial and lingual arches and rest position are built into every Positioner in accordance with best orthodontic requirements. Also effectively eliminates mouth breathing

and undesirable tongue-thrust habits. All cases are individually supervised by Mr. Louis Cettel, the originator of the Acrycett flexible plastic-type Positioner with inner structure. Prompt service with coast-to-coast air mail delivery.

Acrycett

Additional information available at your request

634 S. Western Ave., Los Angeles 5, Calif.

Ph: DUmkirk 8-3914

CALVIN S. CASE Dental Orthopedia and Prosthetic Correction of Cleft Palate

2nd Edition—\$12.00

BRASH

Growth of the Jaws, Normal and Abnormal, in Health and Disease

\$3.50

(Limited number of copies available)

ALL ORDERS PAYABLE IN ADVANCE

Large number of back issues of Orthodontic Journals on hand at all times.

Send me your wants in out-of-print dentistry.

LEO L. BRUDER

1 De Kalb Avenue Brooklyn 1, N.Y.
SPECIALIZING IN OUT-OF-PRINT DENTISTRY

Postgraduate Course in Orthodontics

Temple University announces a two-weeks course in Orthodontics beginning January 25, 1953, under the direction of Dr. Robert H. W. Strang.

This course is given to practicing Orthodontists only. The cost is \$150.00, exclusive of instruments and books.

Applications can be made to:

DR. LOUIS HERMAN

Director of Postgraduate Studies
Temple University School of Dentistry

3223 North Broad Street
Philadelphia 40, Pennsylvania

A MODERN DENTAL REFERENCE LIBRARY

PERIODONTIA—A Study of the Histology, Physiology, and Pathology of the Periodontium, and the Treatment of Its Diseases. By HENRY M. GOLDMAN, D.M.D., SECOND EDITION. 661 pages, 488 illustrations, 18 in color. PRICE, \$12.50.

BIOCHEMISTRY OF THE TEETH—By HENRY M. LEICESTER, Ph.D., 306 pages, illustrated. PRICE, \$5.00.

OUTLINE OF HISTOLOGY—By MARGARET M. HOSKINS, Ph.D., and GERRITT BEVELANDER, Ph.D., SECOND EDITION. 112 pages, illustrated. Size: 9x11-in. PRICE, \$3.50.

DENTAL CARIES—Mechanism and Present Control Technics as Evaluated at the University of Michigan Workshop. Edited by KENNETH A. EASLICK, A.M., D.D.S., 234 pages, illustrated. PRICE, \$5.00.

RESTORATIVE DENTISTRY—By JEROME M. SCHWEITZER, B.S., D.D.S., 511 pages, 1014 illustrations. PRICE, \$15.00.

ORAL REHABILITATION—By JEROME M. SCHWEITZER, D.D.S. 1161 pages, 1157 illustrations. PRICE, \$20.00.

BONE AND BONES—Fundamentals of Bone Biology. By JOSEPH P. WEINMANN, M.D., and HARRY SICHER, M.D., 464 pages, 289 illustrations. PRICE, \$10.00.

DENTAL PROSTHETIC LABORATORY MANUAL—By CARL O. BOUCHER, D.D.S., 410 pages. PRICE, \$4.50.

COMPLETE DENTURES—By MERRILL G. SWENSON, D.D.S., F.I.C.D., F.A.C.P., 726 pages, 882 illustrations, 10 in color. PRICE, \$12.50.

ORAL SURGERY—By KURT H. THOMA, D.M.D., IN TWO VOLUMES. 1521 pages, 1631 illustrations, 121 in color. PRICE, \$30.00.

ORAL PATHOLOGY—By KURT H. THOMA, D.M.D., THIRD EDITION. 1559 pages, 1660 illustrations, 78 in color. PRICE, \$17.50.

ANESTHESIA IN DENTAL SURGERY—By STERLING V. MEAD, D.D.S., SECOND EDITION. 638 pages, 223 illustrations. PRICE, \$12.50.

BASIC PRINCIPLES AND TECHNIQS FOR COMPLETE DENTURE CONSTRUCTION—By VICTOR H. SEARS, D.D.S. 416 pages, illustrated. PRICE, \$5.00.

PHARMACOLOGY AND DENTAL THERAPEUTICS—By HERMANN PRINZ and U. GARFIELD RICKERT. Revised by EDWARD C. DOBBS, D.D.S., NINTH EDITION. 567 pages, 35 illustrations. PRICE, \$7.50.

Theory and Practice of CROWN AND BRIDGE PROSTHESIS—By STANLEY D. TYLMAN, A.B., D.D.S., M.S., F.A.C.D., SECOND EDITION. 960 pages, 1273 illustrations, 9 in color. PRICE, \$12.50.

PRACTICAL ORTHODONTICS—(Original Text by the Late Martin Dewey) By GEORGE M. ANDERSON, D.D.S., SEVENTH EDITION. 556 pages, 640 illustrations. PRICE, \$10.00.

ORAL HISTOLOGY AND EMBRYOLOGY—Edited by BALINT ORBAN, M.D., D.D.S., SECOND EDITION, 350 pages, 265 illustrations, 4 in color. PRICE, \$8.00.

ORAL ANATOMY—By HARRY SICHER, M.D., 570 pages, 310 illustrations, 24 in color. PRICE, \$15.00.

DENTAL ANATOMY—By ROBERT C. ZEISZ, D.D.S., F.A.C.D., F.I.C.S., and JAMES NUKOLLS, D.D.S., F.A.C.D., 486 pages, 427 illustrations. Size: 8½x11-in. PRICE, \$14.00.

ADVANCED RADIODONTIC INTERPRETATION—By CLARENCE O. SIMPSON, M.D., D.D.S., F.I.C.D., 78 pages, 150 illustrations on 10 full page inserts. PRICE, \$10.00.

REVIEW OF DENTISTRY—Edited by JAMES T. GINN, B.S., D.D.S., 824 pages. PRICE, \$5.75.

DOCTOR AND PATIENT AND THE LAW—By LOUIS J. REGAN, M.D., LL.B., SECOND EDITION. 545 pages. PRICE, \$10.00.

An Introduction to the HISTORY OF DENTISTRY—By BERNHARD WOLF WEINBERGER, D.D.S., IN TWO VOLUMES. 1008 pages, 313 illustrations. PRICE, \$20.00.

ESSENTIALS OF ORAL SURGERY—By V. P. BLAIR, M.D., F.A.C.S., and ROBERT H. IVY, M.D., D.D.S., F.A.C.S. Collaboration of JAMES BARRETT BROWN, M.D., F.A.C.S., FOURTH EDITION. 635 pages, 485 illustrations. PRICE, \$8.00.

DISEASES OF THE MOUTH—By STERLING V. MEAD, D.D.S., FIFTH EDITION. 1050 pages, 633 illustrations, 63 in color. PRICE, \$12.50.

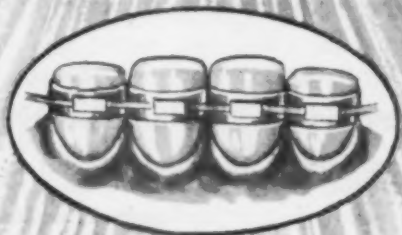
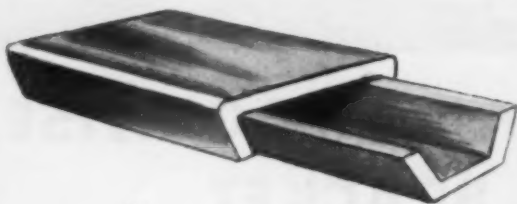
ORAL SURGERY—By STERLING V. MEAD, D.D.S., THIRD EDITION. 1448 pages, 805 illustrations, 16 color plates. PRICE, \$15.00.

PHYSIOLOGICAL FOUNDATION OF DENTAL PRACTICE—By L. L. LANGLEY and E. CHERASKIN. 512 pages, 149 illustrations. PRICE, \$8.25.

The C. V. Mosby Co., Publishers, St. Louis 3, Mo.

TRU-CHROME FOR STRENGTH AND PRECISION

THE
TRU-CHROME
Twin-Arch
BRACKET



Positively precision made, the Tru-Chrome Twin Arch Bracket rounds out the Tru-Chrome line of supplies for every individual operator's preference in Twin Arch mechanisms.

Tru-Chrome cannot corrode. It cannot harm human tissue. Although superior to all other orthodontic metals, it is the least expensive of any reliable material.

This Bracket is supplied pre-welded to Tru-Chrome .100 x .004 Band Material.

PLEASE ORDER BY NUMBER

No. 222—Brackets
on Band Material\$6.00 doz.
No. 223—Caps 3.60 doz.
No. 224—Complete Units
Brackets and Caps..... 9.60 doz.



ROCKY MOUNTAIN METAL PRODUCTS CO.

1450 GALAPAGO ST.

P.O. BOX 1887

DENVER 1, COLO.

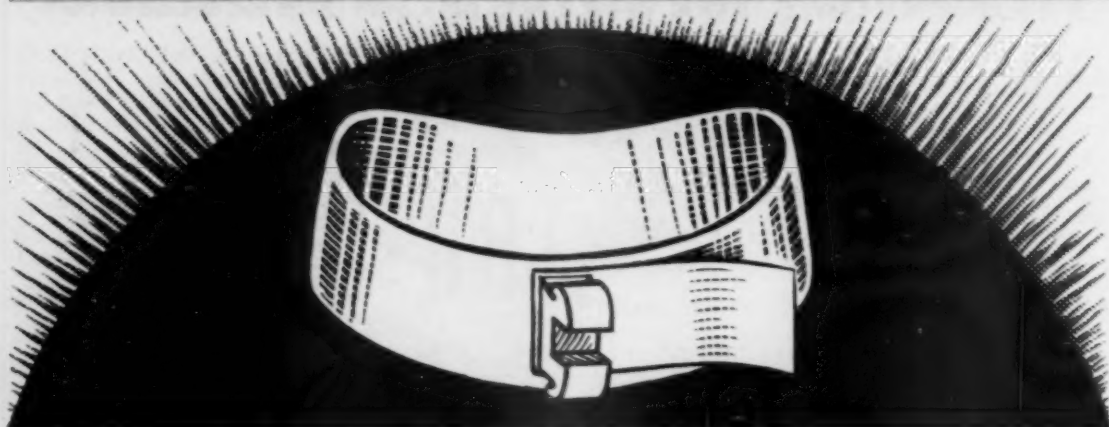
East Coast Distributor: Gilbert W. Thrombley, 220 W. 42d St., New York 18, N.Y.

West Coast Distributor: Karl A. Kreis, 443 Sutter St., San Francisco 8, California

Export Department: P.O. Box 1051, Denver 1, Colo.

HIGHEST QUALITY AT THE LOWEST PRICE

TRU·CHROME: MAXIMUM STRENGTH

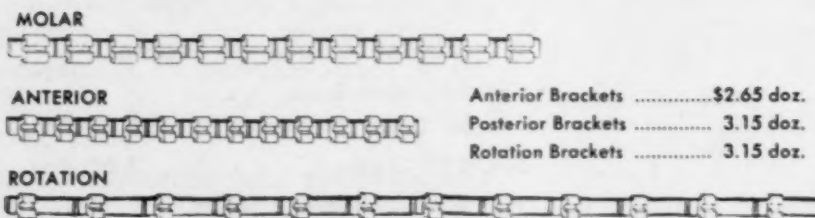


This Is The Tru-Chrome EDGEWISE ROTATION BRACKET

A Very Useful Supplement to a Very Popular Group of Materials

The new Edgewise Rotation Bracket is manufactured exactly like Rocky Mountain's Edgewise Anterior Bracket except one flange is longer so that it may be engaged as a rotation spring. These brackets are furnished in strips of twelve, flanged for spotwelding, and scored for easy detachment.

The extended welding flange serves as a spring resting against the arch wire. It can be used for mild or extreme rotations. The Rotation Bracket works quite rapidly and the tooth can be rotated at the same time it is moved labially from linguoversion.



Anterior Brackets\$2.65 doz.
Posterior Brackets 3.15 doz.
Rotation Brackets 3.15 doz.

CATALOG FREE ON REQUEST



ROCKY MOUNTAIN METAL PRODUCTS CO.
1450 Galapago P. O. Box 1887, Denver 1, Colo.

East Coast Distributor: Gilbert W. Thrombley, 220 W. 42d, New York 18, N. Y.
West Coast Distributor: Karl A. Kreis, 443 Sutter Street, San Francisco 8, Calif.
Export Department: P. O. Box 1051, Denver 1, Colo.



TRU·CHROME: NON-CORROSIVE; TISSUE TOLERABLE

American Journal
of
ORTHODONTICS

(All rights reserved)

VOL. 38

MAY, 1952

No. 5

Original Articles

AIMS, AIDS, AND AUXILIARIES

FRANCIS J. LOUGHLIN, D.D.S.,* JAMAICA, NEW YORK CITY, N. Y.

IN THIS article an attempt will be made to show instances where the use of one appliance or auxiliary seems to be superior to another and how a better over-all system may be obtained by borrowing the advantageous principles from one technique and using them in conjunction with another.

It is certainly not intended that the devotees of any one appliance therapy be belittled or be lauded. All of the appliances in use today have their advantages as well as their disadvantages. To condemn any one therapy because of its disadvantages is to deny oneself the superior efficiency and the ability to get better and more lasting results in some case categories or to sometimes spend much more time and energy than is necessary in other types of cases. If one were to be limited to the use of only one appliance, then that one should probably be the edgewise, for with it any type of movement or combinations of movements can be obtained. However, cases vary in their severity as well as in their requirements, and it would be inefficient to go to the trouble of placing bands on all of the teeth and making the numerous ligations to those bands if just as good results could be obtained by using a far more simple appliance, auxiliary or part.

A good example of this is found in the matter of bands and brackets. Those of us who are familiar with the twin arch technique can attest to the splendid rotation and antirotation—mesiodistal tipping and antitipping qualities which the wide twin wire brackets offer. The same advantage may be obtained with the edgewise method if molar-width brackets are used on the anterior bands. These same molar-width edgewise bands and brackets may also be used with the twin wire technique. With such a setup the operator with a little practice can learn to tie the twin wires to the brackets, and he will not be plagued by bent or distorted channel brackets, broken snap-type

Presented before the Northeastern Society of Orthodontists at the Hotel Commodore, New York, N. Y., March 5, 1952.

*Clinical Instructor, Graduate and Post-Graduate Orthodontics, Columbia University, New York, N. Y.

brackets, or lost caps. Later, if he needs to use torque force, he can switch the treatment to the edgewise rectangular wire without removing or making new bands.

When a person speaks, the teeth most easily and most often seen are the four upper and lower anterior ones.

Unfortunately, gold bands tarnish in some mouths more so than in others, and dark, dirty, tarnished anterior bands make some orthodontic patients that much more self-conscious during treatment. Because they retain their luster and do not tarnish readily, stainless steel or nickel chrome bands look much better in the front part of the mouth. In comparison with the conventional gold anterior bands, they are less time-consuming, because welding may be performed more quickly and easily than annealing, fluxing, soldering, pickling, hardening, and polishing.

The manufacturers of both gold and steel products would do well to make molar-width brackets on such band strips and bands available to the profession without the necessity of placing a special order for them. They are far superior and could be used by more practitioners. Another improvement would be if a hole were drilled superoinferiorly through the base of the bracket for the accommodation of a ligature wire in correcting gross rotations as in the twin arch technique. Depending on the rotation, the band could be placed with the bracket hole on the mesial or distal side of center and rotation springs and staples would be, for the most part, uncalled for in the front of the mouth.

In edgewise cases the cuspids and bicuspid bands are usually the most troublesome teeth, both to band and to keep the bands on. This is because of the pronounced slopes on those teeth. The convex buccal surfaces of the bicuspid bands and the concave lingual surfaces of the cuspids usually offer very little retention potential for bands. The surfaces at the gingival thirds of those teeth are more nearly parallel to each other, and so they offer better retention. However, placing conventional edgewise bands on the gingival thirds for retention would result in carrying their bracket slots too low in relation to the position of the slots on the other bands in the mouth. A great step forward in solving this problem was made with the introduction of the contoured edgewise band strips with the brackets soldered offset as conceived by Dr. Downs. One type is especially fabricated and contoured for use on cuspids and another slightly different type is especially made for use on bicuspid bands.

The Downs types have their brackets soldered closer to the incisal or occlusal edges of the cuspid and bicuspid bands. This permits the operator to place the bands farther gingivally for better retention while leaving the bracket slots in their proper positions on those teeth. If a conventional band were placed farther gingivally, the slot would be in incorrect position and when leveling wires were used, those teeth would be moved to be more occlusal than other teeth in the mouth.

The bands are also cut and contoured to fit the anatomy of those teeth better.

Before inserting the ends of the cuspid band strips into the Angle band forming pliers it is wise to bend the edges so that when they are fitted into

the vise beak of the pliers the band strips will not be at right angles to the beaks but will slope labially and occlusally. When the band is put on the cuspid, the slotted beak will then be found to be parallel to the lingual slopes of the cuspids and band adaptation will be facilitated.

When a round gold wire rotating spring is necessary, it should always be soldered close to the gingival edge on the buccal surface of the band as far away from the bracket and as far interproximally as the rotation will permit. This increases its rotating qualities by offering the longest lever arm possible. The soldered end of the round wire spring is always located on that side of the buccal surface of the band which has to move buccally in order to correct the rotation. When the arch wire is inserted the spring is activated and has a tendency to move the tooth lingually as well as rotate it. In order to prevent that unwanted lingual movement it is necessary to have a ligature tied to the same side of the buccal surface of the band on which the round wire spring is soldered.

Usually a staple is soldered close to the soldered end of the spring but located on the band occlusally to the arch wire. In those few cases where, due to tipping of the tooth, the staple must forcibly be placed closer to the occlusal edge of the band, it sometimes pulls the band loose from the tooth or causes a tearing of the band material when its ligature is tightened.

This can be largely prevented if a greater area of the band is covered with solder where the staple is attached. The solder spread distributes the force of the ligature pull over a wider surface of the band material, thus reducing the tearing tendency, and it also reinforces the band by making it less flexible so the edge of the band will not pull away from the tooth so readily.

Many operators use a solder disc to attach the staple. Solder in wire form is easier to use and can be made to spread over a wider area for the reasons just described.

A staple must have both of its legs attached to the band. This demands time and accuracy and is a strain on the eyesight.

A little gold washer which looks like a ring or miniature white gold doughnut is superior to the conventional staple in some respects. Having no legs, it is much easier to solder. With the larger pool of solder used as previously described, it can be immersed in the solder so that a ligature can be fed through its lumen without catching the wire on the attached base of the ring. In other words, the ligature wire can be run along the band material up the solder and through the ring, without the wire catching on the ring itself.

If a means of a ligature attachment must be put on the lingual surface, the staple is a better choice because it is rounded like the tread part of an auto tire. The ring has sharp edges like a flat metal wagon wheel and might irritate the tongue. On the buccal side, the arch wire and brackets keep the cheeks away from the rings so no trouble is encountered there.

If unforeseen rotations occur during treatment, they might be taken care of by means of a temporary rotating spring. This auxiliary permits rotations to be performed without the necessity of removing the band and performing spring soldering and recementation operations.

The end of a piece of 0.016 inch round wire is bent around the beaks of a No. 442 plier and inserted between the arch wire and the tooth and into the occlusal bracket wing as shown in Fig. 1, *A*. The spring is then swung in the direction of the arrows until it is parallel with the arch wire as shown by the dotted line. This movement snaps it under the gingival bracket wing. The free end of the wire can be presoftened by heating it in a flame. It is bent occlusally (Fig. 1, *B*) so that it rests on the far side of the bracket of a tooth about two teeth away from the one being rotated. This will hold the spring in place and prevent it from moving mesially or distally. The excess is cut off and the wire may be ligated to, or bent around, the main arch wire at that point. The staple or ring on the side of the tooth which is to be moved toward the arch wire is ligated to the arch. This is an easily forgotten but important step.

Looking at the spring from the occlusal (Fig. 1, *C*), the reader can see that it is to extend buccally from the tooth being rotated. This is done so that when its free end is snapped under the arch wire (arrows) a definite tension for rotation will be set up in the wire. Over-rotation is desirable to prevent relapse. The anterior teeth having conical roots should be over-rotated at least one-eighth of a turn past the normal position while posterior teeth should be turned about one-sixteenth of a turn beyond the normal. The flatness or height of the cusps as well as the degree of opening of the free-way space will all play a role in how well the rotations will be maintained after correct interdigitation is obtained. After active use of the spring is discontinued, the same staple or ring should be kept tightly tied to the arch wire to act as a retainer. Whenever possible, rotations should be performed during the use of round arch wires because there is less friction in the bracket slots and the teeth are being freed in the interproximal areas while they are leveled. (During later mesial or distal movements, etc., the teeth may have a tendency to be squeezed and will not rotate as readily.)

If the anchor molars are found to be rotated, they may be corrected by the following method. If the case is being handled with labiolingual therapy, the 0.040 inch arch wire can be used; or if twin wire, an 0.035 inch wire arch used in 0.036 inch buccal tubes. If the case is being handled by the edgewise method, an 0.020 inch round wire arch will usually do the work well.

Fig. 2 shows the application of a round arch wire in order to achieve the rotation of a lower left molar. The arch wire is bent to the usual form for the case but *extreme lingual* bends are made at, or just distal to the stops which rest against the mesial ends of the buccal sheaths. In this particular example the arch wire is then held *upside down* and the *left* end inserted in the *left* sheath while the right side segment of the arch wire is outside of the mouth to the left of the patient's left cheek. The right side of the wire is then passed downward and toward the right. It passes the chin area (arrows) en route and is inserted into the sheath on the right side. The arch wire is then ligated to the brackets. The lingual bend in the left end of the arch wire permits the arch wire to be inserted into the sheath with ease when the wire is upside down. Then, when the right end of the wire is passed under to assume the

normal rather than the inverted position, the wire rotates in the left sheath and the original lingual bend then rotates the tooth. For the opposite side the procedure is the same except that the inverted right side is first placed in the right sheath and then the left side of the wire is passed under the chin to the left. It cannot be passed upward because the loop or stop would usually strike the

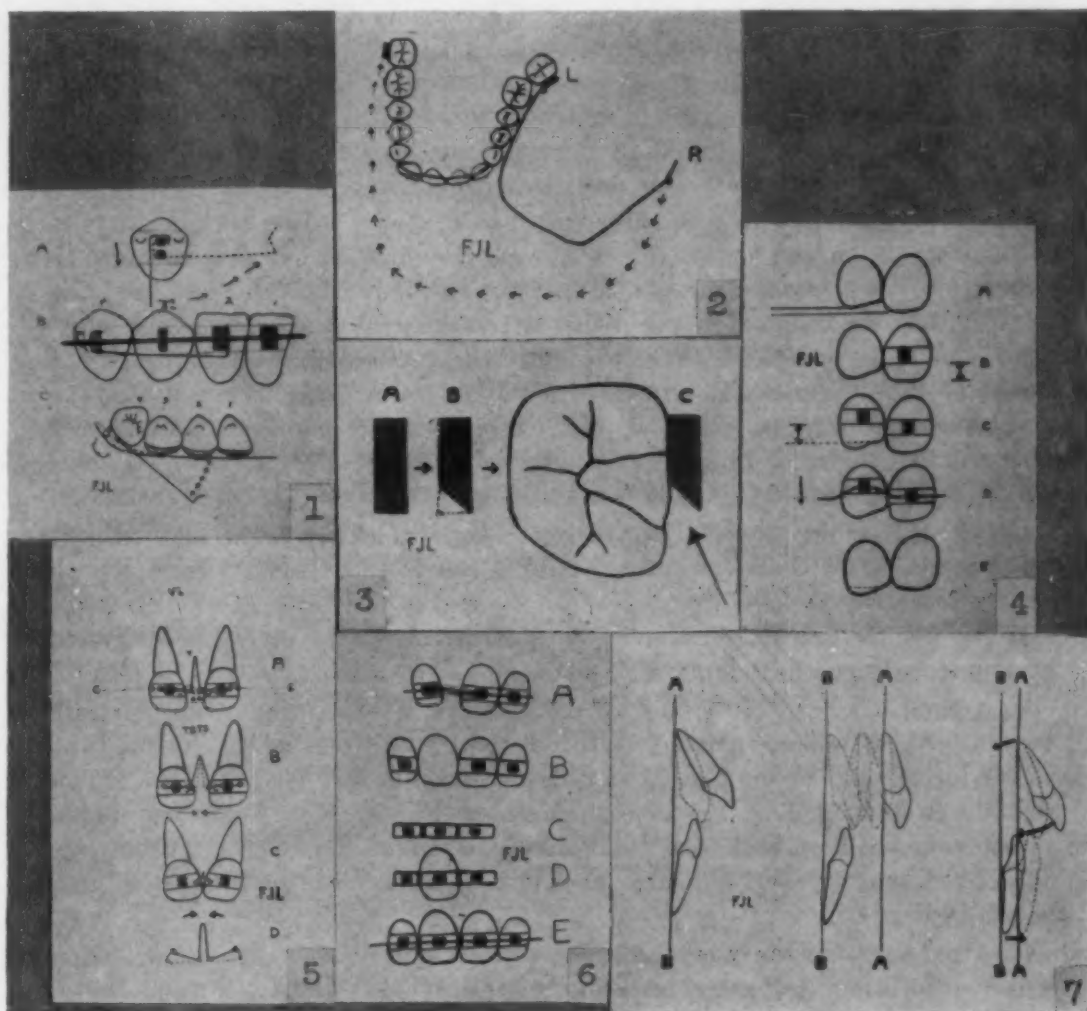


Fig. 1.—A, Insertion of removable rotating spring; B, locked in place; C, occlusal view.

Fig. 2.—Rotating a lower left molar.

Fig. 3.—A, Sheath from factory; B, sheath trimmed; C, sheath soldered; arrow denotes niche for tieback ligature.

Fig. 4.—A, Comparison of incisal edges and crown lengths; B, arrows indicate distance of band from incisal edge; C, position of band on broken tooth; D, leveling arch moving tooth incisally.

Fig. 5.—A, Spaced teeth; VL, vertical loop; c, coil of softened ends of edgewise wire; TS, tie spur.

B, Ligature wires activating loop (exaggerated).

C, Crowns together and rings tied.

D, "Bird in flight" bend; dotted lines indicate activation position; large arrows show root movements.

Fig. 6.—A, Coil spring opening space for pontic; B, pontic fitted and trimmed; C, bands soldered together; D, pontic cemented; E, full assembly.

Fig. 7.—Left diagram, A, plane of upper root apex, superimposes B, plane of lower root apex; middle diagram, AA, upper apex plane, to BB, lower apex plane (exaggerated); right diagram, arrows indicate movements.

buccal surface of the molar. If the rotation has to be performed on an upper molar, the wire has to be passed upward and over the nose and then to the other side for the same reason. If rotations are bilateral they must be corrected one at a time.

Fig. 3 shows a diagrammatic view of the occlusal surface of an anchor molar which has a very flat buccal surface. If a buccal sheath is soldered on such a band, the distal end of the sheath will be flush against the band and there will be no place for a tieback ligature wire to catch on. Of course, the arch wire may be left overly long so that it protrudes through the end of the sheath, but the wire may irritate the cheek tissues, especially when the arch wire is moving backward through the sheath as in a vertical loop project.

A nice ligature wire catch may easily be made by taking the sheath as it comes from the supply house (Fig. 3, *A*) and trimming off one end, as shown in Fig. 3, *B*. The shortened end is then soldered on the band, as in Fig. 3, *C*. The ligature may be inserted in the niche as indicated by the arrow. All sharp edges should be smoothed off. Care must be exercised in the dinking of the sheath so that the niche is formed with the narrower 0.021 inch width of the sheath soldered against the band. This is important because, if the sheath is trimmed and soldered the wrong way, the edgewise wire cannot be used later, for the 0.028 inch width of the lumen would lie vertically instead of horizontally.

Fig. 4, *A* shows a normal incisor next to one which has been fractured. If the amount of tooth structure broken off is considerable, some form of crown restoration must be done where the pulp canal width permits. However, if the break is not too far up the crown, the unesthetic appearance can be disguised and improved upon in the following manner.

A band, made to fit the normal tooth, is cemented in proper position with regard to the bands on the other teeth. The distance from the edge of the band to the incisal edge of the normal tooth is measured by means of calipers. (This distance is indicated by the arrows shown in Fig. 4, *B*.) The same caliper measurement is used and some point along the ragged edge of the broken tooth is selected as a new incisal edge. A band is positioned on the broken tooth, as shown in Fig. 4, *C*.

After the bands have been cemented, very light leveling wire or twin wires are used to bring the broken tooth into position (Fig. 4, *D*). The gauge of the wire to be used is judged by the difference in height of the bracket slots. During movement, the fibers of the periodontal membrane and the ligamentum circulare are considerably stretched; therefore the movement must be performed very slowly. It is surprising to see the tooth move and bring its gingival attachment along with it. No exposure of cementum is seen.

As the slots approach the same plane, the excess incisal edge of the broken tooth is trimmed off so that the incisal edges are even (Fig. 4, *E*). As the trimming is done, a thicker area of tooth structure is encroached upon. This necessitates the simultaneous removal of some tooth structure on the lingual side of the crown to reduce the labiolingual thickness and enable the newly positioned broken tooth to occlude with its antagonists. (Excessive thickness would force

the new incisal edge to be located too far labially.) Care must be exercised during the trimming, but if dentine is inadvertently exposed, it should be treated with some protective medicament. All trimmed surfaces should be polished with rubber wheels.

Because the fibers have been stretched, it is best to hold the tooth in the new position for a period of time, otherwise a rapid relapse might occur.

Usually, the procedure is contraindicated for very young children, unless the radiographs disclose that the wall protecting the pulp chamber is sufficiently thick to permit the trimming.

The result is good functionally as well as esthetically, and the slight difference in crown lengths is hardly noticeable.

Some of the causes of anterior diastemata are:

1. An overly low frenum, i.e., one which is still low even though the permanent cuspids have fully erupted. Upon stretching the frenum a blanching can be seen in the tissue lingual to, and between, the central incisors.
2. A severe overbite, wherein the lower incisors strike high on the lingual surfaces of the upper incisors, causing the latter to flare and space.
3. Cases with congenitally missing lower second bicuspid often show retention of the much wider lower second deciduous molars. The latter do not always become ankylosed. The upper teeth become spaced due to the greater amount of tooth structure in the lower, causing a discrepancy in arch sizes.
4. A difference in the ratio of the sizes of the teeth in one arch as in cases of small peg-shaped lateral incisors or one or more overly large mandibular incisors.
5. Missing teeth and the consequent drifting and spacing.
6. Rotated incisors and resulting diastemata.
7. Lower lip-biting in such a manner as to move the upper teeth labially and cause spacing.
8. Thumb-sucking and the resulting spacing.
9. Unerupted supernumerary teeth causing diastemata.
10. Undersized proximal restorations.

With the exception of the mixed dentition, "ugly duckling" stages when diastemata may be looked upon as being natural until the full eruption of the upper cuspids, an attempt should be made to close the space or spaces but only after the cause has been determined and can be eradicated. To close up the spaces and leave the cause unremedied would result in certain relapse.

When the cause has been determined and can be eliminated, intraoral radiographs should be scrutinized to determine the positions of the apices of the roots of the spaced teeth. If they are close together and there is a divergence of the long axes of the teeth as the crown regions are approached, the crowns may be brought together by any of the familiar means. However, if the radiographs show that the roots are parallel to each other or the root apices are diverging or a considerable distance apart, then bringing the crowns together and leaving the root apices distal to the crowns usually will result in relapse, the

crowns swinging back to the distal when the active treatment is discontinued and the spaces becoming visible again. It is usually necessary to bring the roots, as well as the crowns, closer together.

This may be accomplished as shown in Fig. 5. In *A* the separated teeth are banded and an 0.021 by 0.025 inch edgewise wire is bent as shown. Brass wire spurs, 0.018 inch, are soldered at the ends of each of the legs of the closed vertical loop. The edgewise wire is burned to anneal it just to the distal of where it passes through the brackets. The ends of the softened wire may then be bent into small circles and lip irritation avoided. Ligature wires can be run from each mesial staple to the arch wire to avoid rotation of the teeth as the crowns and then the roots are brought together.

A ligature wire is laced in the form of a figure eight running from one spur to the bracket of the tooth on the same side as shown in Fig. 5, *B*. When both spurs are so tied to their respective brackets, the vertical loop is opened. The opening should not be more than the thickness of a thin dime from passive to active position. To go beyond this measurement of opening would result in a severe compression of the periodontal membranes along the mesial sides of each root and a rapid tearing and stretching of the fibers along the distal root surfaces. Hemorrhages would occur with necrosis as a follow-up. The latter would impede movement as healing would be taking place rather than the desired osteoclastic action on the mesial and the osteoblastic activity on the distal walls of the sockets.

Adjustments should be timed so that only intermittent pressure is exerted. In other words, the vertical loop should be active for a week and a half and then remain in a passive state for about a week, after which it can be reactivated. Continuous pressure is contraindicated. After the crowns are together, a ligature wire is run through each mesial staple and tied as shown in Fig. 5, *C*. This will keep the crowns together while the root apices are being brought closer to each other. The tie should be just tight enough to hold the teeth together. If the ligature is tied too tightly, the teeth will rotate toward each other. The same vertical loop wire may be used or a new one constructed and bent in the "bird in flight" position as shown in Fig. 5, *D*. In order to place it in the brackets, it has to be sprung to the position indicated by the dotted lines. As it returns to a passive state, the root apices will be moved toward one another. As in the case of most movements in orthodontics, overcorrection is sought. After the root apices are properly positioned, the mesial rings are kept tied to each other, and the treatment of the other problems of the case continued with twin wires or a single wire. A figure eight tie may also be made connecting the brackets.

In those Class II cases complicated by peg-shaped or undersized lateral incisors, the space for a proper sized lateral incisor may be preserved during distal movement by the following method. After the central incisors have been brought together and space gained for the lateral incisor, an impression can be taken of the undersized tooth and a die made. On the die a crown can be made of gold or acrylic and as wide as the case calls for. If the crown is of gold, a bracket is correctly located and soldered on. If the crown is made of acrylic,

a band is cemented in proper position and the crown can then be cemented on with zinc oxide and eugenol and used all during orthodontic treatment. If the proper width is not obtained and maintained as desired, it would be difficult to interdigitate the other teeth correctly with their antagonists and have them remain there. Due to loss of proximal contact, drifting would occur and esthetics would also be poor.

In those cases where an anterior tooth is missing, extracted, or lost, the problem can be met with in the following manner. In many such cases the diastema caused by the absent tooth brings about an open-bite relationship. This is due to the fact that the patient habitually thrusts his tongue into the space. Closure of the open-bite and a correction of the Class II relationship (if one is present) is difficult to accomplish because the appliance is attempting to move the teeth one way and the tongue play is resisting such movement. The sooner the space is filled, the earlier the patient will discontinue the tongue habit and the faster the treatment will be concluded. Habits should be corrected as soon as possible.¹

The space should be opened by coil spring (Fig. 6, *A*) until it is the same width as the space occupied by the same type of tooth which is present on the other side of the arch. An acrylic pontic such as those used in denture work is selected for matching color and size (Fig. 6, *B*). After the pontic is trimmed to fit the gingival and to clear the intended occlusion, a band is adapted so that it is as far up on the tooth as the bands are on the teeth either side of the space. The band is removed and its outer interproximal surface is soldered to the band or bands next to it (Fig. 6, *C*). The band is then cemented to the pontic tooth (Fig. 6, *D*). After the cement has set, the band or bands soldered alongside are then cemented in place, thus supporting the artificial tooth (Fig. 6, *E*). When the arch wire (or wires) is fed through the bracket the pontic is further supported. The tongue will be kept away from the space and treatment will then progress more rapidly and the appearance and mental outlook of the patient will be greatly enhanced. An acrylic tooth pontic is used instead of porcelain because it more readily permits the application of additional material at its gingival border in case a space occurs there as the bite is closed and the teeth move incisally.

The condition which we orthodontists are most often called upon to correct is the Class II, Division 1 category.

In the past, many investigators^{2, 3} have pointed out the various different tooth-basal bone-jaw bone-cranium relationships which are found in this classification. Because their requirements differ, it would seem that they should be treated differently. Depending upon the type of case at hand, we can treat it by aiming at the epitome in efficiency, simplicity, and rapidity. All three cannot always be attained by always using the same appliance therapy.

For the sake of brevity we can confine ourselves to what may be considered three main types in Class II, Division 1 malocclusion. Fig. 7 (left diagram) shows a type where the root apices of the upper and lower anterior teeth are almost on the same vertical plane *A-B*. In other words, there is a considerable overjet between the incisal edges of the upper and lower anterior teeth but the

root apices are in good position. The retrusion of the flared, labially inclined upper anterior teeth will usually result in an esthetic and functionally sound correction of the overjet.

If there are no severe rotations or mesiodistal tippings of the anterior teeth, then an upper 0.040 inch labial arch will usually work well. If the upper anterior teeth are rotated or tipped, then the twin arch serves as a simple, rapid, and very efficient device. If the upper posterior teeth are badly out of line buccolingually or occlusogingivally or are badly rotated, then an edgewise upper would be called for since the back teeth would probably have to be banded to correct rotations anyway.

If the lower anterior teeth are fairly upright and there are no crowded areas, a lower lingual arch will usually suffice as anchorage in handling this first type. Precautionary measures which may be taken against anchorage slippage are the placing of bands on the lower cuspids with soldered cleats keeping the lingual arch gingival, or by soldering spurs off the lingual arch and in contact with the distal surfaces of the long-rooted cuspids. Light, gentle elastic pressure should be used throughout and any tendency toward anchorage slipping continually noted for prevention.

The lower first bicuspids can be tied to the lingual arch. If there are lower anterior rotations without crowding or the lower incisors are lingually inclined or tipped mesially or distally, correction including space closures can be done nicely with a twin wire assembly. After such corrections, a lower flat labial wire can be used along with a lingual arch to augment the anchorage.

There should be no expansion across the cuspid region unless the cuspids were originally lingually inclined. In such event they can usually be at least uprighted without danger of relapse. In many overbite cases the lower cuspids are often lingually inclined and after opening the bite they can usually be uprighted and will not relapse if there is no interference in lateral excursions.

If there is a considerable curve of Spee in the lower or if there are gross tippings or rotations of the posterior teeth or if the anchorage potential seems poor, a lower edgewise appliance is the choice and can be used in combination with whatever seems best in the upper.

In Fig. 7 the middle diagram shows another type of Class II, Division 1 *purposely exaggerated*.

This second of the three types we are discussing presents an overjet relationship of the root apices as well as the crowns of the upper anterior teeth. This can be readily recognized in profile radiographs. Crowns can be moved back until the upper and lower incisal edges approximate each other by using a simple labial arch or a twin wire, but in this second type (unless a severe maxillomandibular growth dysplasia is present) the root apices must also be moved back. If they are not, then the upper anterior teeth will assume a lingual inclination which will leave the case unesthetic and faulty functionally. Torque force is necessary to move the root apices and so the edgewise appliance is indicated in this type.

Due to inexperience or hearsay many operators have not taken full advantage of the potentialities of the orthodontic armamentarium available. They

shy away from torque or even the thoughts of it. Most of the fear is centered around the possibility of causing root exposure, root resorption, or both. Root denuding can be performed if one is not mindful of the fact that the apex is at a considerable distance from the bracket. A slight adjustment at the bracket results in a widening and movement at the root tip. The capable operator would not permit this to happen; the appliance itself is not at fault.

In regard to root resorption, investigations have shown that in those predisposed types, resorption will occur regardless of the appliance used. It is very true that root resorptions can be brought about more readily by the edgewise mechanism but this is because there is far more power available than is usually needed. To use an analogy, a capable automobile driver would not press the accelerator down to the floor while he drives through Main Street traffic.

Excellent anchorage is necessary in utilizing torque with distal movement, so a complete edgewise assembly is needed in the lower as well as in the upper.

In between these two extremes of Class II, Division 1 is found a third type, shown in Fig. 7, right diagram.

In these cases there is an unfavorable relationship of the root apices, but it is not as severe as in the second type. After using a simple labial arch or a twin wire assembly, some of those cases can be finished with a correct axial inclination of the upper anterior teeth while others which are almost identical at the outset of treatment finish with lingually inclined upper front teeth.

Of course the operator could insert the edgewise appliance at the very start of all of these puzzling cases and then, if it were needed, torque could always be resorted to in order to prevent getting unwanted lingual tipping results. That would certainly enable us to meet the requirements of efficiency, but it would not always be the fastest or simplest way. This is so because, as we know, some of those cases could be finished just as well by using other appliances which avoid the extra time, effort, and investment which the edgewise requires.

For a few moments let us cogitate on why cases of this third type react differently and how we may treat them in the most efficient, simple, and rapid manner.

Many of us have experienced great satisfaction at the results obtained when these patients have been treated using a Johnson appliance with a flat wire rather than a twin wire. The flat wire has a tendency to keep the teeth upright, whereas the twin wire has been shown to permit the unwanted lingual tipping more readily. However, some teeth tip even though the flat wire is used. Why the difference?

As the twin wire wizard recommends, elastics are used in these cases until condensation of the upper anterior teeth takes place, and they are touching the lower front teeth. Then coil springs are compressed against the molar tubes and are used in conjunction with the elastics to move the posterior teeth distally.

Is it not possible that in some cases the lower jaw actually comes forward slightly under the influence of the reciprocal action of the Class II elastics? Such a movement occurring simultaneously with the lingual retrusion of the

upper teeth would reduce the overjet from its lingual as well as labial aspect. Many of us have seen cases beautifully and completely corrected without using coil springs whatsoever. There are other cases whose Class II molar relationship is partly corrected during the condensation of the anterior teeth, and coil springs against the molar tubes are needed for only a short period of time to complete the molar correction.

In some cases that correction was probably due to the upper posterior as well as anterior teeth moving back. In other cases, it was probably due to the lower jaw coming slightly forward while the upper anterior teeth were being condensed, and in still other cases the correction might have occurred due to a combination of distal movement of all of the upper teeth as well as a slight forward movement of the lower jaw.

The very mention of a possible forward movement of the lower jaw seems like heresy and outmoded thinking, so we had better probe it deeply. We have all seen the dual or so-called "Sunday bite" wherein some Class II patients have been told to bite in a Class I relationship with or without an accompanying inclined plane device or other removable appliances. Those of us in university clinics see only too many of the unfortunate results of the attempts usually on the part of untrained general practitioners or poorly informed self-styled orthodontists who attempt to correct cases using that method. The patients come to the clinic as a last resort after months or years of futile effort to gain a correct, permanent relationship.

Last summer I visited some of the outstanding practitioners in Europe. In discussing various orthodontic problems with these men I learned that the majority of our European colleagues treat most of their Class II patients with removable appliances to condense upper anterior teeth and to bring the lower jaw forward as well. Most of their patients are treated in the *mixed* dentition and therein seems to lie the secret of their cases which terminate successfully. Most of them readily declare that they are not too happy with their results when such procedures are applied to most of their *permanent* dentition cases.

It has been shown that the glenoid fossae are comparatively flat in the deciduous dentition stage. As the child grows older the fossae usually become more concave. Because they are undergoing natural growth changes in shape at that time, might they not be slightly adaptable to further change if the condylar heads are exerting pressure on them?

When the elastics are worn, the lower jaw, being used as anchorage, is subjected to a forward pull from the elastics and the growth center beneath the condylar head may also be influenced. With the European method the inclined planes on the removable appliances could be doing the same thing. This could explain their successful mixed dentition treatment when removable appliances are used.

Later, when the permanent dentition is erupted and a curve of Spee is in evidence the fossae are usually considerably curved and concave. The mandibular muscles and ligaments have assumed a physiological rest position which

in turn determines the physiological rest position of the lower jaw. Attempts to change this status quo on a permanent basis in the permanent dentition usually result in failure.

Although most older glenoid fossae are concave, some are more concave than others. Or, to put it another way, some are comparatively flat.

Would it not seem very possible for the mandible to be able to move slightly forward in cases where the older fossae are fairly flat?

Since the forward movement is only slight and the muscles and ligaments are used to accommodating to a forward movement along fairly flat fossae when the jaw goes into protrusive, a slight permanent change may be tolerated.

This may be an explanation of what is present when our European friends do get successful results even with permanent dentition, and what may be an accompanying factor when only myofunctional therapy is successfully used. What is more pertinent to us right now is that it may also be an underlying factor in the third type, or borderline cases, some of which are successfully terminated without using torque and employing the flat arch only.

Even if we were to radiograph the fossae it would be rather foolish at this time to predict or depend upon a forward movement of the mandible taking place. As yet, it has not been proved that it is probable or possible on a permanent basis; on the contrary, it is known that relapse does occur when an attempt is made to carry it out to any great degree. Whether it can be done on a small scale in all cases having flat fossae or whether the latter are the only governing factors is still conjecture. If it can and does happen, fine, but it should not be depended upon as taking place.

What then can we do about it? As has been said, the simplicity of the labial or twin wire appliances makes them first choices in clear-cut cases. Likewise, the edgewise is first choice where it is recognized that torque or strong anchorage will be definitely needed.

Now for those borderline cases where trouble may be encountered—at first it may appear to be sacrilegious to the dyed-in-the-wool advocates of each technique to use the following suggestions, but why can we not become open-minded and use the advantages of each therapy, and do away with the disadvantages?

A practical solution to the problems would seem to be the use of molar-width edgewise brackets on anterior teeth in twin wire as well as in edgewise cases. The torquing qualities of the edgewise mechanism may later be used if needed without changing bands. It means placing bands with molar-width edgewise brackets on the upper anterior teeth and treating with a twin or flat wire. The upper right and left first molars are banded as usual, but edgewise buccal sheaths are soldered on in their correct positions. Occlusally to the sheaths, round 0.036 inch buccal tubes are soldered for the accommodation of end tubes during the time twin wire treatment is employed. The latter may be used for the entire treatment but, in case torque is needed, the buccal edgewise sheaths are ready to be used. Since the buccal tubes are so low occlusally, bends must be placed at the anterior ends of each end tube so that the posterior ends of the end tubes are parallel with the buccal tubes and the anterior ends

are parallel with the slots in the brackets on the anterior teeth. This must be done, otherwise the twin or flat wires would be incisal to the brackets and cause extrusion of the anterior teeth.

As the treatment continues, if torque is needed, edgewise bands can be placed on the remaining unbanded teeth. The buccal segments can be brought back with sectional arches or by means of a canine spur full arch, both methods incorporating tip-back bends with Class II elastics for mass distal movement. Following the correction of the Class II relationship, the anterior teeth can be brought back by means of a double vertical loop closing arch with Class II elastics. Torque can be applied in the anterior section of that arch after condensation has occurred. Torque can be increased in the finishing arch and in this manner the root apices as well as the crowns can be brought back to give better esthetics and function in the finished case. Lingual inclinations of the crowns of the upper front teeth are prevented from occurring.

When apices of the anterior roots have been moved lingually by torque force (Fig. 8, *A*) care must be exercised in making the retainer. In Fig. 8, *B* the letter *P* denotes the plastic palatal portion of a retainer and the *W* denotes the portion of the labial wire. Neither *P* nor *W* is on the same plane and, as a result, when the retainer loops are tightened to close spaces left by the band material, there is a tendency to pivot the tooth about the plastic, causing the root to relapse back to its former position. In *C*, both the wire and plastic are on the same plane for better retentive quality.

At best, removal of teeth is a compromise, and should only be done after careful consideration. Some of the most valuable information in this regard can be obtained by reviewing the wonderful works of some of our own Northeastern Nestors, namely: Salzmann,⁴ Porter,⁵ Strang, Greenstein, Ross, and Waugh.⁶

We should not go overboard for or against extractions. It is just another instance where a liberal viewpoint is required in this highly fascinating field of ours. When teeth are moved in extraction cases, they usually tip. It is necessary to position roots correctly in order to eliminate the tipping results so that the teeth will not relapse back to where they came from and thus open up spaces in the extraction areas. The edgewise has no peer in this regard, and in the descriptions to follow that is the system used.

In the treatment of those Class II, Division 1 cases which do require extraction, the most practical procedure is to remove the upper first and the lower second bicuspid. This is preferable to removal of just the upper bicuspid alone, because in the latter an unbalanced case results due to wider upper cuspids fitting into the narrower space formerly occupied by the extracted first bicuspid. There is disharmony in tooth number between upper and lower jaws, disharmony in tooth size in occlusion, and, when the upper arch is left in Class II, inclined planes and ridges and grooves which were never meant to occlude with each other are left to attempt to do just that. Judicious trimming still does not give the results which can be obtained with just a little more effort, namely, removing four units, not just two. It is better to take out the lower

second bicuspid because the resulting spaces usually offer enough room to move the first bicuspid back to eliminate the crowding in the anterior region and satisfy the incisor-mandibular plane angle for the case. It also permits the lower molars to come forward. This is all to the good for, by doing so, the molar Class II relationships will be partly corrected. The problem in the upper arch is to

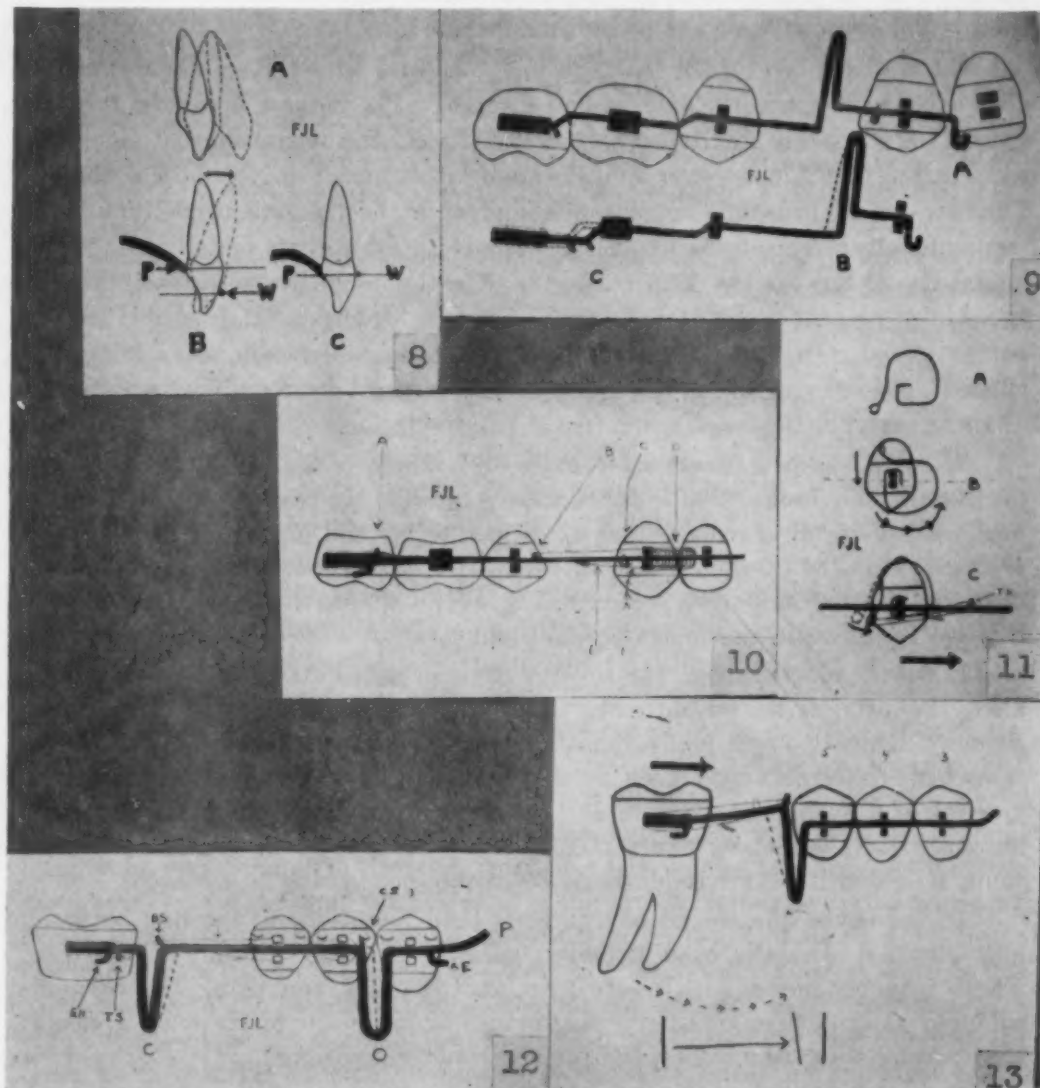


Fig. 8.—A, Crown and root moved lingually; B, root apex tipping labially due to pressure of labial wire W against P, palatal portion of Hawley retainer; C, P, and W correctly positioned on the same plane.

Fig. 9.—A, Dual purpose sectional arch; B, sectional arch moved forward and loop activated by tying back spur to sheath C.

Fig. 10.—A, Tie-back spur; B, 0.018 inch brass wire spur; C, ring tied to arch; D, coll spring; F, ligature wire fed under bracket wings; E, ligature wire left uncrossed.

Fig. 11.—A, Shape of spring; B, insertion; C, activation; TS, tie spur.

Fig. 12.—Double vertical loop; P, passive arch adaptation; E, Class III elastic hook; O, open loop; CS, canine spur; BS, bicuspid spur; TS, tie spur; EH, Class II elastic hook; C, closed loop.

Fig. 13.—Mesial molar movement without mesial tipping of tooth.

move the buccal segments back to a corrected Class I interdigitation with their lower antagonists, then move the upper cuspid back, and then finally the four upper anterior teeth.

The sectional arch depicted in Fig. 9 serves a twofold purpose. The arrangement shown in Fig. 9, *A* is used to move the upper buccal segment teeth distally. If the bracket slots are not on the same plane at the start of the case, another flat sectional arch can be inserted first, to level them.

The tip-back bend 0.021 by 0.025 inch edgewise wire vertical loop sectional arch is bent as shown in Fig. 9, *A* and inserted. The patient is advised to wear Class II elastics continually. The force of the elastics is transmitted along the wire to the 0.028 inch brass spur located just anterior to the buccal sheath. This presses against the anchor molar and with the tip-back bend, that tooth moves distally. The tip-backs on the other teeth move them distally also. The mesial leg of the vertical loop is shorter than the distal leg, so a tip-back relationship is present to guide the cuspid. During this stage, the vertical loop is not activated. In some cases, as the upper buccal segments move back, the Class II elastics can bring the lower molars forward by reciprocal action and in a manner to be described.

When the upper buccal segment is back where it is decided it should be, the arch is slid forward so that the most posterior tip-back bend rests against the distal of the first molar bracket. The anterior end of the sectional is bent so that it is in the form of a hook for Class II elastics continuance and is located flush against the mesial of the cuspid bracket. The arch is now free to slide through the bicuspid and molar brackets and sheath.

Elastics are continued for several days so as to start osteoclastic action along the distal of the cuspid root. Then, the vertical loop may be activated by tying a ligature around the brass spur and sheath. When the ligature is tightened, the arch moves back as shown in Fig. 9, *C* (dotted lines) and the vertical loop opens as in Fig. 9, *B*. Elastics are continued to prevent forward movement of the molars, and the cuspids are brought back. To prevent rotations, it is sometimes advisable to tie the distal cuspid ring to the arch.

In the lower, the second bicuspid has been removed and the first bicuspid, and possibly even the cuspid, moved back to eliminate the lower crowding. These may be moved back by full arches tied back and using Dr. Strang's soldered clock springs or safety pin springs or by means of sectional arches if considerable forward movement of the lower molars is desired.

Some newer and novel methods of moving teeth along an arch wire now follow. Fig. 10 shows an adaptation of a method which was introduced by a north-western area group comprising Drs. Lewis, Bishop, Fraser, and McGovern. It is a very worthy and efficient auxiliary. A full arch wire is bent to correct form, and coil springs (or spring, if the movement is unilateral) are fed along the arch wire before any stops are soldered. These coils can be made by winding 0.010 inch spring wire around an 0.030 inch core, or lighter wire may be wound on a smaller core if preferred. Some operators prefer to heat treat these springs.

The opened spring is cut to the measurement of the distance between the brackets as in Fig. 10, *D*. It must be remembered that the stops and spurs are not soldered in their correct positions until after the open coil springs have been fed along the arch wire.

A full arch wire is used with stops flush against the sheaths and tied back as in Fig. 10, *A*. A spur (Fig. 10, *B*) is soldered about 2 mm. mesial to the bicuspid bracket in this particular instance. The case described is a Class I first bicuspid extraction. One end of an 0.010 inch soft ligature wire is fed lingual to the arch wire and then brought labially. The upper and lower ends are then crossed on each other in front of the mesial end of the coil spring and then twisted one turn. This twist or small pigtail is now located on the labial side of the arch and should be moved to the lingual side. This is done by taking the upper end of the ligature wire and passing it lingually to the arch wire, thus pulling the twist lingual to the main arch also. The twist prevents the wire from slipping over the coil upon compression. The ends of the ligature wire are then passed (Fig. 10, *E*) distally under the bracket wings *F* and looped around the post *B*. Some operators cross these wires distal to the tooth to be moved so as to keep them close to the main arch for tightness. If the antagonist teeth do not strike the ligature wire, it is better not to cross them for that only forms a convergence of the wires and the bracket of the moving tooth will find resistance. Anchorage is strained and movement impeded. The ligature tie twist can be made near the spur and tucked lingually. In small mouths where the lip commissure would interfere with plier manipulation so far back in the mouth, the tie may be located farther forward and pressed parallel to the wire.

When the ligature is tightened and tied, the coil is compressed against the bracket and the tooth moves. Stringing the ligature under the bracket wings will usually prevent gross rotation, but a ligature may be tied from a ring to the arch wire (Fig. 10, *C*) as an extra-precautionary measure. (Sheath tie-back spurs [Fig. 10, *A*] are of 0.028 inch brass wire, and arch wire spurs [*B*] are of 0.018 inch brass.)

When a tooth is to travel along a rectangular arch wire, the wire should usually be made round to decrease further strain on the anchorage. One may use a stone wheel to round off the wire, or the arch wire can be coated with wax except in the area to be thinned. The wire is then dipped in an anodic polisher and the size reduced. Thinning the wire will permit the moving tooth to tip more because of the increased play in the bracket, and due to imperfections and indentations along the wire surface there might be a tendency for a locking to occur by the bracket edge meeting a depression in the wire. Jiggling as a result of functional occlusion will cause the tooth to move up and down and the binding will usually be inconsequential. The slight additional tipping could also be corrected by occlusion and later by means of an A bend arch.

Instead of using a ligature wire to activate the coil spring, a Russell lock can be inserted mesial to the coil spring on the arch wire and moved along the arch until the spring is compressed. The lock screw is then tightened. When the spring needs reactivation the procedure is repeated. The locks can be sterilized and used again.

If a tooth has to be moved only a small distance along an arch wire then a removable spring can be used.

Fig. 11 shows the removable traction spring which was introduced by Clifford Whitman. An 0.016 inch round wire is bent in the form depicted in Fig. 11, *A*. The section which is to grip the bracket wings is bent around the beak width of a 442 pliers. This gives just the right width at that point.

The spring is first placed vertically between the arch wire and the tooth and brought into place from the gingival side. After the part of the wire having the same width as the 442 pliers is snapped under the gingival bracket wing, the wire is moved in the direction shown by the arrows, Fig. 11, *B*, and assumes the position shown in Fig. 11, *C* (dotted lines). As the wire is moved around the bracket, it becomes engaged in both occlusal and gingival bracket wings.

The spring can be bent slightly labially so that it presses against the lingual side of the arch wire. This can be done to prevent rotation during tooth movement. The spring is activated by tying it to a brass 0.018 inch spur which is soldered on the arch wire out of the way of tooth movement, or by tying it to a Russell lock favorably located in the arch wire. The large arrow in Fig. 11, *C* denotes the direction in which the tooth will move.

The full arch wire (round or edgewise and with stops tied back to the molars for complete anchorage) is engaged in but not tied in to the bracket of the moving tooth. This reduces anchorage strain through friction and facilitates movement of the tooth. The spring may be reactivated as often as needed and then easily removed. If desired, it can be sterilized and used over again.

When teeth have to be removed, discretion rather than a set rule should be used. If it is decided that a case must be treated via the extraction route and the space gained by the extraction of four bicuspid is not enough, the four first molars can be removed. Another instance of molar removal might be in those cases where bicuspid would ordinarily be removed, but it is noticed that they have no caries or restorations while one or several first molars are missing or they are all present, but deeply filled or carious.

When molar removal is indicated, the bicuspid and cuspid can be individually move distally by clock, coil, or safety pin springs, etc. If it is desired that all bicuspid in one arch be moved distally simultaneously, the following method can be employed. An 0.021 by 0.025 inch edgewise wire is bent as shown in Fig. 12. The vertical loop (Fig. 12, *C*) is located fairly close to the mesial of the molar so that it will not interfere with the distal movements of the bicuspid. Some operators prefer using an annealed gold arch wire, bending the arch to the ideal chart form and then slightly modifying it to fit the mouth and hardening it before insertion. Others prefer fabricating it directly from the mouth. In either case, a brass 0.028 inch tie spur (Fig. 12, *TS*) is soldered and tied back to the molar sheath. The distal loop is made so that it is passively closed (Fig. 12, *C*). A brass 0.018 inch bicuspid spur (Fig. 12, *BS*) is soldered on the mesial leg of the *C* loop. If necessary, a canine spur (Fig. 12, *CS*) is soldered to the distal leg of the open loop (Fig. 12, *O*).

In the anterior region, the arch is bent and adapted to fit the bracket slots as they lie. (No attempt is made to level them.) This is done to enable the arch

wire to enter the brackets of the anterior teeth in a passive state (Fig. 12, *P*) so as not to disturb their slight but helpful anchorage potentialities. Upon activation, a ligature wire (Fig. 12, *L*) is run from Fig. 12, *BS* to the second bicuspid. This pulls Fig. 12, *BS* mesially toward the bicuspid, as the arch wire slides through the bicuspid brackets. The *C* loop opens and the *O* loop closes as shown in the dotted lines. As the loops return to a passive state, the arch wire between *C* and *O* moves distally carrying the second bicuspid along with it because of the ligature tie.

If the first bicuspid does not follow through interseptal fiber pull, a ligature is run from it to *BS* or a figure eight ligature is tied, as shown. If it is necessary to move the cuspid distally, the *O* loop is made closer to the mesial of the first bicuspid bracket for noninterference, and the canine spur *CS* is tied to the cuspid bracket. If necessary, additional anchorage can be obtained by using a Class III elastic from the elastic hook *E* (0.028 inch brass wire) to the upper anchor molar. A full arch with stops tied against the sheaths should be used in the upper. If a headcap is used to augment the upper anchorage when Class III elastics are required, the upper bicuspid may be made to move distally at the same time. Fig. 12, *EH* is an 0.028 inch brass wire spur used later with Class II elastics to help bring the molars forward when necessary.

Fig. 13 shows the vertical loop arrangement used to bring a molar or molars forward. It may be utilized in Class II, Division 1 extraction cases as mentioned previously or in molar extractions after the bicuspid have been moved back. An 0.021 by 0.025 inch edgewise wire is bent to proper form, with vertical loops formed just distal to the bracket of the second bicuspid. The distal leg of the vertical loop is longer than the mesial leg, which automatically forms a tip-back force on the molar. An 0.028 inch brass tie spur is soldered on the occlusal end of the distal leg of the vertical loop. It must be made small and inclined mesially so as not to interfere with the buccal cusps of the upper teeth, which may be in close proximity to it when the teeth are occluded.

When a ligature is tied around the spur and the sheath and then tightened, it will open the loop as shown by the dotted lines. The tip-back will force the root apices mesially, thus keeping the mesial portion of the crown high, and mesial tipping will be prevented. Upon reaching the distal of the second bicuspid, the proper crown contact point relationship can be made. Being correctly positioned forward, the root apices also prevent relapse tendencies and permit the crown to be level and at proper height throughout its mesiodistal length. Thus good occlusion can be obtained and maintained. As mentioned before, in all space closure and extraction cases it is always wise to position the adjoining teeth so that their long axes converge toward their root apices in order to prevent relapse drifting. This can be admirably attained using the the edgewise arch with "gable roof" or A bends incorporated in it.

As our own Joseph Eby⁷ says, "A good doctor is one who treats his cases at the right time, and in the most simple, rapid and efficient manner possible." We can follow that good advice only if we are familiar with the manipulation

of each of the most popular appliances. Then we can combine their principles and parts to the best advantage depending upon the problems of the case. Our common aims can be fused with common aids and auxiliaries.

We in the Northeastern Society can feel very proud of the fact that within our membership we have, in addition to those nationally known names previously presented, other men who represent the ultimate in knowledge and experience in various appliance categories, among them are Arthur Totten, a labiolingual leader; Clare Madden, a twin wire wonder; and Robert Strang, the dean of the edgewise effort. Through their untiring efforts many practitioners in this as well as other societies have benefited immeasurably.

Until that day when the appliance is invented which satisfies all requirements, let us learn and use all of the techniques, thereby keeping this society open-minded and second to none.

REFERENCES

1. Whitman, Clifford: Habits Can Mean Trouble, *AM. J. ORTHODONTICS* 37: 647-661, 1951.
2. Case, Calvin: Dental Orthopedia, Chicago, 1921, C. S. Case Co., pp. 246-289.
3. Fischer, Bercu: Treatment of Class II, Division 1 (Angle). II, *AM. J. ORTHODONTICS* 34: 461-489, 1948.
4. Salzmann, J. A.: Criteria For Extraction in Orthodontic Therapy Related to Dento-facial Development, *AM. J. ORTHODONTICS* 35: 584-610, 1949.
5. Porter, Lowrie: Conservatism in Orthodontic Procedures and Appliances, *AM. J. ORTHODONTICS AND ORAL SURG.* 33: 109-140, 1947.
6. Strang, Robert, Greenstein, Arthur, Ross, John, and Waugh, Leuman: The Advisability of Extraction as a Therapeutic Aid in Orthodontics, *New York J. Dent.* 17: 90-106, 1947.
7. Eby, Joseph: Personal communication.

8559 168TH ST.

THE PHYSIOLOGIC BASIS OF RELAPSE

A REVIEW OF THE LITERATURE

GEORGE W. HUCKABA, B.A., D.D.S., MEMPHIS, TENN.

PREFACE

"A biologist can do two things besides discovering facts of human evolution and genetics. He can tell his fellows how to achieve the ends they desire already, such as care and prevention of disease. He can tell them of possibilities at which they had not guessed, such as the possibility of making childbirth painless, or some of the possibilities of which I will speak later. But he can never tell them what is worth doing. That is always an ethical, not a biological question. In what follows, I shall say that I think certain things are worth doing, that it is better to be born with a normal mouth than hare lip, with normal color sense than color blind, and so on. These are my opinions as a human being. If you disagree with them I cannot, as a biologist, persuade you to change your opinion. But if you agree, then, as a biologist, I may be able to help you work for the ends on which we agree."¹⁷—J. B. S. Haldane
(Copyright, *The Atlantic Monthly*, March, 1947.)

THIS impressive quotation assumes yet a deeper meaning for the orthodontist as he seeks to make an objective appraisal of his completed orthodontic cases. We are not justified in judging the merit of our services on the basis of our successes alone, but we must also consider those instances in which we must concede that results could have been better. If we are truly honest with ourselves, we will not claim the universal immunity of "difference of opinion" to explain our lack of success. This, again, is an ethical question. We should consider what our chances of permanent success in the treated case actually are. It is the purpose of this paper to present the varied opinions of our best investigators on these considerations which include the determination of what constitutes the basis for a stable result, and what factors aid in its retention, as well as those which can bring about relapse of the treated case.

Hellman¹² maintained that failures in orthodontics are either the original or slightly altered conditions of malocclusion which have been treated but not corrected. Failures are usually due either to the incompetence of the operator, or to unknown or uncontrollable factors which interfere with the attainment of results. Failures present an entirely different problem from relapses.

Hellman¹² continued with the statement that relapses are disturbances occurring in cases which have been successfully treated. The term "relapse" is actually a misnomer. Relapse implies the return to a former undesirable state. The unique feature of relapses in orthodontics is that although there is a return to an undesirable state, it is not usually exactly as it was before, and is often decidedly different.

This thesis was prepared as a partial requirement for Certificate of Competence in Postgraduate Orthodontics, University of Tennessee, College of Dentistry.

Waldron³¹ was of the opinion that there is no phase of orthodontic treatment which is more important than the functional retention of the finished case. The production of an ideal occlusion avails us but little if it is to be followed by a mass migration of the teeth back to their former positions, and the attendant facial disharmonies which are associated with malpositions of the teeth and jaws.

STATEMENT OF THE PROBLEM

Hellman¹² pointed out that the problem of retention has faced the orthodontist from the very beginning. The technique of insuring lasting results was inadequate in the days of Angle so that patients seen after the customary "six months' retention period" usually displayed some undesirable change. According to Hellman, Angle himself admitted that many of his best results "went back." The retreatment of cases was the order of the day.

Hellman¹² observed that it was not until 1935 at the meeting of the New York Society of Orthodontists that orthodontic misadventures were frankly and openly discussed. Since this time much has been written about failures, even more has been said, but nothing has been done to prevent them. We are in almost complete ignorance of the specific factors which cause relapse. Until such knowledge is made available to us we should abide by the fundamental principles of treatment planning and diagnosis which have been established in orthodontic circles. Webster³² suggested that the competent orthodontist must include a consideration of the retention problem in his treatment plan before any active treatment is instituted.

Margolis²⁰ and Waldron³¹ agreed that the first requisite for the prevention of undesirable posttreatment shift of the teeth is a satisfactory treatment result with the establishment of the proper relationship of the opposing teeth, and the arches with one another as well as with the cranial base. According to Waldron,³¹ Hellman emphasized that a satisfactory result must be accomplished before considering retention.

Tweed³⁰ listed the objectives of orthodontic therapy as follows:

- a. Permanence of tooth position or stability.
- b. Health of the investing and supporting tissue that will assure longevity of the denture.
- c. A mechanically efficient masticating apparatus.
- d. The best in facial esthetics.

Litowitz¹⁸ mentioned the fact that it was in 1940 that Downs stated the three major problems which confront the orthodontist in the attainment of his objectives. First, there is the danger of abnormal shifting of the teeth causing a perverted relationship to their bases. Second, we may be dealing with denture bases which are abnormal in their relationship to the cranium, and frequently to each other. Third, both of these conditions may complicate the case.

Tweed³⁰ summarized the problem very well when he published the six fundamental requirements which must be met if normal occlusion is to be established. They are as follows:

- a. There must be a full complement of teeth and each tooth must be made to occupy its normal position.

- b. There must be normal cusp and inclined plane relationships of opposing teeth.
- c. There must be normal axial inclinations of all the teeth.
- d. There must be normal relationship of the teeth to their respective jaw-bones.
- e. There must be normal relationship of the jaws to each other and to the skull.
- f. Normal function of all the associated parts must be established.

Tweed³⁰ added that it is obviously impossible to satisfy all these conditions in every case, so that it becomes necessary to compromise on some requirements. Good functional occlusion of all the teeth and normal function of the associated parts are essential. Surprisingly enough, if these conditions are not satisfied, the resulting relapse causes improvement of facial esthetics in many cases.

The preceding discussion was intended to give some conception of the problems involved in securing permanent results in orthodontic treatment, and to review some of the requisites to this end. Let us now consider some of the factors which directly affect the progress of treatment, and posttreatment maintenance of tooth position.

FACTORS INFLUENCING THE PROGRESS OF TREATMENT

Sved²⁹ maintained that the best orthodontic results may be obtained in patients who are in an active growth phase during the period of active treatment. Litowitz¹⁸ said that in general, cases having the most rapid growth during the treatment period showed the least amount of disturbance of axial positioning and the smallest degree of relapse subsequently. Sved²⁹ observed that adjustment of the denture through function would seem to demand a certain amount of growth. In his evaluation of Hellman's statistics, Krogman¹⁶ suggested that this is a narrow margin in which to work since during the first five years of life the face gains 78 per cent of its height, 85 per cent of its width, and 82 per cent of its depth. This means that after five years of age only 15 per cent to 20 per cent of growth increments remain as avenues of possible readjustment.

Fischer⁸ recommended treatment of cases in the mixed dentition period since there is an immediate improvement in facial balance, and the active growth period which is coincidental with treatment directs growth rather than attempting to repair damage already done.

Brodie³ pointed out that tooth movement does not appear to be as great as clinical observation would lead us to believe. On the basis of his cephalometric studies, he concluded that growth and development account for a considerable part of the changes which take place during orthodontic treatment.

Sved²⁹ believed that the growth of the alveolar process is more rapid than that of the basal bone in the late mixed dentition and early adult dentition periods. A period of readjustment through function should be allowed to take place after the completion of the adult dentition. This will allow the growth of the basal bone to overtake that of the alveolar bone and restore harmony to the face. We should not make the mistake of judging the facial characteristics of young individuals by adult standards.

Tweed²⁰ maintained that periods of impaired health during the period of growth and development exert an adverse effect upon osseous growth. When something is lost in bone growth, nothing can be regained at a future date. Most of the patients who come in for treatment have a discrepancy between the amount of tooth material and the accommodating capacity of the basal bone. This discrepancy must be eliminated by the removal of tooth material if normal occlusion is to be established. Basal bone will not grow under the influence of orthodontic stimulation.

According to Howes,¹⁵ Lundstrom published a paper in 1923 in which he pointed out the necessity for the removal of teeth in order to gain the best possible results in some orthodontic cases. This policy was contradictory to the teachings of Angle who insisted upon the maintenance of a full complement of teeth. Tweed followed with the reaffirmation of Lundstrom's premise and gave added support to the extraction plan.

Howes¹⁵ concurred with the generally held view that a normal occlusion must be supported by a normal apical base. The width of the apical base, measured above the apices of the maxillary first premolars, governs the dental arch width in the premolar region. Unless the width of the base is greater than the inter-premolar width measured between the buccal surfaces of these teeth, the only way arch width may be increased in this region is by the distal movement of the premolars to a wider part of the base. Grieve⁹ contended that overexpansion of the arches will result in collapse of the case. Extractions are mandatory when tooth material is so excessive as to prohibit proper alignment of teeth over basal bone. A wise decision in this regard may be obtained only after careful consideration of the growth potentialities of the individual is made. According to Grieve, Noyes stated that he does not believe that the growth potentialities of the individual can be changed, nor his individual type altered by orthodontic treatment or any other means.

Madsen¹⁰ stated that occlusion is the resultant of a dynamic balance of forces, not a static condition. Hemley¹⁴ suggested that the manifold forces of occlusion, which will be discussed in detail later, are in constant operation in the mouth, and that the positions the teeth assume are under the direct influence of these forces. Grieve¹⁰ observed that function is also an important factor in the determination of facial form. He agreed with Hemley¹⁴ who asserted that since there is a close coordination of form and function in the denture, a perversion of one adversely affects the other. Conversely, a normal position of the teeth is conducive to normal alveolar bone form.

Hemley¹⁴ pointed out that when artificial forces are imposed upon this balance, the movement of teeth in an effort to accommodate is the result. Orthodontic forces are designed to produce just such an effect. Since this paper deals with the re-establishment of a favorable balance after the removal of appliances, it is well to review the physiologic aspects of the response of bone and teeth to these movements.

TISSUE RESPONSE TO ORTHODONTIC TOOTH MOVEMENT

Oppenheim²⁴ stated that in response to mild orthodontic forces osteoclasts remove bone by uniform lacunar resorption. The lighter the stimulus, the

greater is the number of osteoclasts. They continue to be active for a period of at least four days after all active forces are discontinued. These are called "primary osteoclasts." Noyes²³ observed that in these areas where large numbers of osteoclasts are found the resorbed areas begin to undergo reorganization and reconstruction. This reconstruction is a process by which the architectural pattern of the trabeculae is altered from a form designed to withstand occlusal stress to one in which the tooth is subjected to the condition of a bone growing rapidly in a direction determined by a constantly directed force. Here it may be seen, as Oppenheim²⁵ pointed out, that correct diagnosis is a very important factor in treatment since it allows the continuous movement of the teeth in the same direction in which pressure was first exerted.

Noyes²³ demonstrated that there is an increase in periodontal membrane thickness on the side of tension, and a decrease on the side of stress. On the tension side bone grows in long, fingerlike processes or spicules arranged in the direction of force. On the pressure side bone is transformed into spicules lying in the direction of force also, but this is accompanied by resorptions occurring in the medullary spaces, so that the cribriform plate which forms the lining of the alveolus has been cut into pieces which are moved through the cancellous bone which surrounds it. Lewis¹⁷ said that the root of the tooth is always protected during movement by a layer of uncalcified cementum which prevents danger from overloading.

According to Hemley,¹⁴ Oppenheim maintained that the ideal tooth movement is slow enough to allow bone resorption and regeneration to keep pace with it, as in the case of normal growth. No orthodontic appliances known today can satisfy these demands altogether, so that a certain amount of damage to bone, cementum, periodontium, and pulp is unavoidable. In order to reduce this damage to a minimum the force applied must be gentle, elastic, intermittent, and perfectly directed with ample opportunity to allow for repair and regeneration.

Hemley¹⁴ cautioned that in the consideration of a gentle force it must be remembered that not only is the magnitude of the force important, but also the distance the force traverses, the length of time it is operative, and the direction in which it is applied all determine whether a force is excessive.

Litowitz¹⁸ stated that tracings of cephalometric roentgenograms in the area of the mandibular symphysis show that teeth do not move through bone. Rather the alveolar process is remodeled as teeth change their positions. When teeth are moved labially, the alveolar process follows; if relapse occurs, the bone returns with the teeth.

Markus²¹ and Waldron³¹ stated that after the active treatment pressures are discontinued there is a gradual transformation and narrowing of the new bone which simulates normal alveolar bone. A lamellar structure is formed in this new bone, and the trabeculae arrange themselves parallel to the long axis of the tooth.

Oppenheim²⁴ warned that the use of very heavy forces causes the periodontal membrane to be crushed, and undermining resorption takes place around the periphery of the damaged area in such a manner that resorption is not

limited to the direction of intended movement. The osteoclasts which are present in response to these heavy forces persist until all the affected bone, cementum, and crushed tissues are eliminated. These are known as "secondary osteoclasts." When excessive pressures cause wide destruction of tissue, the tooth involved becomes loose. Hemley¹⁴ added that such an unstable tooth requires the aid of retentive appliances for support for a considerable period of time after active treatment has been discontinued if relapse is to be avoided.

Oppenheim²⁴ continued that a heavy force may cause blood vessels to be ruptured on the side of traction with a resultant hemorrhage, impaired nutrition, and toxin formation caused by the decomposition of strangulated tissue. Osteoclasts move in to eliminate this tissue also, and thus there is resorption of excessive amounts of bone on both the pressure and the traction sides with heavy forces. This results in the free luxation of the affected teeth. These cells are known as "tertiary osteoclasts."

Waldron³¹ pointed out that the transseptal fibers of the periodontal membrane run from the cementum at the neck of one tooth in a more or less horizontal direction across the crest of the interdental septum to the cementum of the next tooth. The location and attachment of these fibers would indicate that they serve to maintain the mesiodistal relationship of neighboring teeth and in stabilizing the teeth against separating forces. According to Waldron, Oppenheim stated that when the buccal segments are being moved distally and large spaces appear between the teeth anterior to those being moved, then movement is being carried out too rapidly and the transseptal fibers are being broken.

Oppenheim²⁴ believed that moderate forces must be used if these undesirable reactions are to be avoided. Such forces also give enough time for the formation of osteocytes which deposit osteoid on the traction side in an even layer of greater thickness than is possible with the use of heavier forces. The reduction in the width of the periodontal membrane and the greater resistance of osteoid to resorption greatly limit the extent to which an always possible relapse may take place.

In the preceding discussion we have considered the active tissue response to tooth movement, and how stability is improved by the proper adjustment of force. Tweed³⁰ reminded us that treated cases may relapse in spite of the fact that the tissue response has been favorable if the teeth have not been placed in their proper positions with respect to their own basal arches and the cranial base. The following discussion will be concerned with the work of some of our leading authorities on the subject of proper positioning of the teeth in such a manner that permanency of the result will be maintained.

HOW TOOTH POSITION IS RELATED TO STABILITY

Tweed³⁰ recognized the fact that the attainment of normal occlusion by orthodontic means is limited. Corlett⁶ agreed with Tweed when he said that in normal occlusion the mandibular incisors are always positioned on mandibular basal bone with axial inclinations which fall within the range of normal variation of five degrees to the labial or lingual of the perpendicular. According to Litowitz,¹⁸ it was Tweed who in 1941 asserted that the lower incisor teeth of

an orthodontically treated case must have their long axes perpendicular to the mandibular plane if stability of the completed case is to be the reward of the orthodontist. When such a relation cannot be attained by simple orthodontic means, the elimination of tooth material through extraction should be carried out to make this possible.

Tweed was quoted by Corlett⁶ to have observed in 1945 that most malocclusions, even the apparently simple Class I cases, are characterized by a forward placement of the teeth in relation to the basal bone. This condition is reflected by the axial inclinations of all of the lower incisor teeth relative to the occlusal plane. Litowitz¹⁸ found that orthodontically treated cases which resulted in a greater procumbency of the lower incisor teeth demonstrated post-treatment shift of teeth. In half of the group studied, the lower incisors tended to regain their former axial inclinations; the other half tended to become more procumbent still. Disturbance of the root apex position was followed by a return to the former relation in every case. The limitations imposed upon orthodontic regulation of the lower incisor teeth become immediately apparent.

Tweed³⁰ was of the opinion that the ultimate in facial harmony and functional occlusal balance is achieved only when the mandibular incisor teeth are placed in an upright position over basal bone. It is only in such a position that the lower incisors are best able to resist the forces of mastication which will otherwise almost certainly result in their displacement. The normal relationship of the mandibular incisor teeth to their basal bone is the most reliable guide in the diagnosis and treatment of all Class I, Class II, and bimaxillary protrusion types of malocclusion, and to the attainment of balance and harmony of facial lines and permanence of tooth position.

These principles expressed by Tweed and his followers are not universally held. Sv.d.,²⁹ on the other hand, maintained that as a rule neither the anterior nor the posterior teeth are placed directly over the ridges. The lower incisors are anterior to the ridge, and the lower posterior teeth are lingual to the ridge. The maxillary teeth are placed to the labial and buccal of the ridge all the way around.

Sved²⁹ carried his argument still further when he said that the alignment and maintenance of the lower incisors in an upright position over basal bone is not a requirement for permanent results. There is a great variation in the normal axial inclination of the anterior teeth in different individuals. Axial inclinations of the teeth disturbed by orthodontic management tend to correct themselves following treatment, according to Brodie.

By means of fixed, standardized lateral head roentgenograms, Corlett⁶ reported that Broadbent, Brodie, Margolis, Speidel, and others were able to make accurate readings of the axial inclinations of the lower incisor teeth to a line drawn tangent to the lower border of the mandible. This is known as the incisor-mandibular plane angle. A large number of cases were included in this survey, and each investigator obtained average readings which were within two degrees of the perpendicular suggested by Tweed. Litowitz¹⁸ said that in 1944 Brodie demonstrated a wide range of readings in the incisor-mandibular plane

angle. Although the averages were near the perpendicular, the readings for each individual were held to be as much a personal characteristic as the shape of the nose.

Brodie² concluded that it is fallacious to use a mean value as a criterion for an individual case. Cole⁴ agreed with Brodie and added that when orthodontic manipulation causes too much change in the incisor-mandibular plane angle, balance is violated and relapse will occur. Litowitz¹⁸ was of the opinion that the incisor-mandibular plane angle is constant throughout life in individuals who do not receive orthodontic treatment.

Schaeffer²⁶ maintained that regardless of their axial inclinations, the incisor teeth come to occupy a more posterior relation to their supporting bones as growth of the facial skeleton progresses. This fact may explain the improvement in prognathism as adulthood is reached.

Corlett⁶ devised a method by which the positions of the lower incisor teeth may be studied in normal mouths and in cases of malocclusion. Using the standard profile roentgenograms from the files of the State University of Iowa, he erected a perpendicular to the mandibular plane through the menton. The shortest distance between this perpendicular and the labial surface of the lower incisors was measured. As a result of these studies it was demonstrated that there is no great or reliable difference between the positions of the lower incisors in normal occlusions or in Class I or Class II malocclusions. Thus it is implied that the lower incisors have not drifted forward on the basal bone, but have the same relative positions in normal occlusions and in Class I and Class II malocclusions. This study does not take into account the axial inclinations of the incisor teeth except as this would be affected by the measurements taken.

Strang²⁷ believed that in cases where it is impossible to align the mandibular incisor teeth in an upright position over basal bone without the buccal movement of the cuspids and posterior teeth, the reduction of tooth material by the elimination of dental units is indicated. Cole⁴ said that in these extraction cases nearly all the alteration in the position of the root apices of the lower incisor teeth occurs in a distal direction. The positions of the teeth are stable provided that the normal range of axial inclination is not violated, and the teeth are not moved off the basal bone.

The work of Brodie³ which was supported by Cole⁴ and Litowitz¹⁸ seemed to indicate that the first molar teeth are usually moved anteriorly somewhat to close the space created by extraction. Lower first molars which are tipped during treatment show a strong tendency to resume their former axial inclinations after the removal of appliances. This tendency is prevalent whether the roots, crowns, or entire teeth are moved. The maxillary first molars usually show a tendency to tip mesially in the majority of cases where mesial tipping of the crowns was initiated by appliances.

Brodie³ added that the inherent tendency of teeth to return to their former axial inclinations and positions following treatment is more marked where growth is active. According to Cole,⁴ Margolis maintained that this tendency is a more frequent cause of late anterior crowding than is the eruption of the third molars.

Cole⁴ continued by saying that postretention crowding of the lower anterior teeth may be due to overexpansion of the arches in some cases. When this occurs it is because the teeth are not upright over basal bone. Margolis was said to have reported one case in which the lower incisors were tipped from their original position of 101 degrees to 116.5 degrees during treatment. After retention was discontinued for one year, the teeth had returned to an angular relationship of 106 degrees with the mandibular plane. Litowitz,¹⁸ in another series of cases, stated that it was found that lower arch length which was gained during treatment decreased in the postretention period. Expansions showed a similar collapse, with expansion through the premolar area having the most stable result.

Webster³² reminded us that the procedures which the orthodontist executes during treatment and the sequence with which they are carried out influence the degree of success in the permanence of results. Grieve¹⁰ and Madsen¹⁹ agreed that once a case has been treated and the teeth are in perfect occlusion, no change is condoned. This expectation has little basis in fact, for occlusion is a dynamic balance of forces in which maintenance of form is subject to functional requirements. In this respect, the representation of the occlusion by stone casts is fallacious because the casts are static while occlusion is dynamic.

We have considered the positional requirements of the teeth in an orthodontically treated case, and have shown how this is related to prevention of relapse. There are certain natural aids to retention which may be utilized to advantage in the adequately treated case. A brief discussion of each of these aids follows in the list below.

THE NATURAL AIDS TO RETENTION

1. Dewey and Anderson⁷ suggested that cuspal guidance and inclined plane relationship of opposing teeth are a natural aid to retention. The deeper the occlusal anatomy of the teeth, the greater is the effect. When the occlusion has been adjusted in its fine details so that there is a close, harmonious interrelationship of opposing occlusal anatomy, retention is definitely enhanced. If the teeth should begin to drift, the inclined plane relationship during occlusal contact would tend to return the teeth to their former positions.

Dewey and Anderson⁷ continued by saying that it is easy to appreciate that hypoplastic molars, badly abraded teeth, edge-to-edge bites, and peg lateral incisors do not lend themselves readily to retention. Much stress has been placed upon the Angle classification of malocclusion where occlusal relationships are expressed in terms of the buccal cusp and groove interdigitation. From the standpoint of relapse prevention it is more significant to note that the mesiolingual cusp of the maxillary first permanent molar should occlude well in the central fossa of the mandibular first permanent molar. Functional fixation of the permanent first molars in this manner minimizes the danger of relapse of the buccal segments.

Fischer⁸ pointed out that it is difficult to reconcile the classification and diagnosis of cases on the basis of molar relationship alone. Instability of the

case after treatment may be little concerned with molar relationship. It is for this reason that stability of the treated case should be a major consideration in treatment planning, and not delayed until after the case is completed.

Dewey and Anderson⁷ estimated that the anterior overbite should be established at about the same depth as the anatomical height of the cusps of the posterior teeth. Usually this amounts to about one-third of the cervicoincisal length of the lower anterior teeth. Cole⁴ suggested that the reduction in overbite during treatment is due to depression of the incisors in some cases, and to distal tipping of the molars in others. Cole⁴ and Litowitz¹⁸ agreed that there is a strong and uniform tendency for the overbite which has been reduced by treatment to deepen again when retention is removed in almost one hundred per cent of cases. Litowitz¹⁸ observed that vertical positioning of individual teeth is also very difficult to retain. Teeth which are depressed during treatment quickly regain pretreatment height, and in some cases exceed it.

Cole⁴ thought that extrusion of the incisors may not be the only cause of an increase in the depth of the overbite. In some of his cases Cole found that the increase is due to the forward shift of the molars which permits greater closure of the jaws before the molars come into occlusion. If the maxillary incisors maintain their positions in spite of the increasing overbite, then one would expect the mandibular incisors to be tipped lingually. This is exactly what happens.

Cole⁴ concluded that the interocclusal clearance or freeway space must not be encroached upon in an attempt to decrease the overbite. In cases where extrusion of teeth occurs in excess of the interocclusal clearance, relapse will ensue because the rest position of the mandible is governed by muscular balance. Brodie³ showed that the use of intermaxillary elastics tips the occlusal plane, but it returns to its former relation after retention is removed. Thus we cannot expect to reduce the overbite by tipping the occlusal plane.

Coleman⁵ cautioned that after the teeth have been placed in the best possible positions by orthodontic means, it is necessary to equilibrate the occlusion. Failure to do so with the fond hope that the occlusion will "settle in" without further assistance is to invite disaster. Mesial or distal displacement of the teeth or rotations after the removal of retention herald occlusal imbalance. Buckling of the lower incisors will likely occur later.

Coleman⁵ added that there are two chief procedures in the equilibration of the occlusion. The first is the detailed positioning of all the teeth in the best functional relationship. There is no retaining appliance, nor is there any magic formula which is a substitute for adequate treatment. The second procedure is the selective spot grinding of teeth in all mandibular positions. Skillfully done, the procedure should allow a maximum distribution of stress in centric relationship. The vertical dimension should not be closed. The harmony of the opposing inclined planes thus obtained allows the distribution of eccentric occlusal stresses. There should be a reduction of the guiding tooth surfaces in order that the occlusal stresses may be more favorably applied to the supporting tissues. The sharpness of the cutting cusps should be retained, the food escapeways increased, and the contact surfaces decreased.

2. Dewey and Anderson⁷ reminded us that harmony in size and relationship of the arches is an important natural force of retention. The crowded condition of the dental arches has been discussed previously with the explanation of the need for extraction. These cases may be recognized as the patients present for treatment. Broadbent¹ believed that the complete expression of the inadequacy in the size of the dental arches may not be fully appreciated until years after treatment. Late anterior crowding is frequently seen.

According to Broadbent,¹ Wood referred to the third molars as the fifth columnists of orthodontic practice. Broadbent observed that many orthodontists have seen some of their prize cases relapse upon reaching late teenage and become a failure in both the eyes of the patient and the parent. In such cases the collapse of the lower dental arch is coincident with the partial eruption or impaction of the mandibular third molars. This syndrome occurs as well in patients who have not been subjected to orthodontic treatment.

Factual evidence gathered by Broadbent¹ in the Bolton study over a twelve-year period does not indicate that the third molars are guilty of dental crowding and case relapse. The findings would indicate that the third molars are co-suffers with the incisor teeth as a result of the failure of the facial skeleton to attain its complete adult size and proportions. According to the Bolton study, third molar impaction is an indication of aberrant facial development which also finds expression in the incisor region.

3. Dewey and Anderson⁷ told us that muscular pressures and balance are a very significant natural force of retention. Waldron³¹ cited the work of Rohde in Fig. 1. This is a diagram of the buccinator and its associated muscles which form a kind of functional, elastic sling which keeps the denture confined and thus preserves its integrity from the buccal and labial aspects. In this way the proximal contact relationship of adjacent teeth is maintained, as is also the mesiodistal relationship of adjacent teeth. Swinehart²⁸ invited our attention to the fact that as the crowns of the teeth migrate away from the basal bone in the process of eruption and take their places in the mouth, their positions are governed by the environmental forces acting upon them. The labial and buccal confinement of the dental arches by the muscular sling mentioned is opposed by the powerful muscles of the tongue.

Dewey and Anderson⁷ believed that this muscular balance is upset in mouth breathers so that the orbicularis oris loses its tone and the upper lip is shortened. Hartsook¹¹ quoted Johnson as saying that not all children who hold the mouth open habitually are mouth breathers. In the same article Johnson was reported to have described the classical type of malocclusion associated with mouth breathing as embodying narrowing of the dental arches, protrusion of the maxillary incisors, supraversion of the mandibular incisors, lack of vertical development in the premolar and molar areas, and distal relationship of the mandible to the maxilla. The upper lip is usually shortened; the lower lip is thickened and protruded; the nostrils are underdeveloped; and there is a general lack of tone in the facial musculature.

In contrast to these findings, Hartsook¹¹ reported the work of Huber and Reynolds who maintained that mouth breathing is not confined to one specific

type of malocclusion, but is well distributed among all types. Hartsook concluded that mouth breathing is not a primary etiological factor in the production of malocclusion.

Dewey and Anderson⁷ were in accord with the generally held view that treatment which corrects only the protrusion of the teeth, but does not restore tone, position, and development to the lip muscles and the muscles of facial expression is doomed to failure.

Strang²⁷ noted that every malocclusion represents a denture under the influence of, and stabilized by, balanced muscular forces which are inherent in the individual and cannot be changed by any known means of treatment. Muscular forces are present in the form of muscular tonus and muscular contractions. Successful treatment, as evidenced by permanent stability, must preserve this muscular balance rather than attempt to alter or upset it.

Strang²⁷ continued by saying that the mandibular cuspid and mandibular first molar teeth are the key in determining the alignment pattern for the remaining teeth so that it will be harmonious with the muscular forces which act constantly upon the denture. For this reason, stability of the result can be assured only when the width of the denture in the mandibular cuspid region and mandibular first permanent molar area is maintained. If muscular balance is maintained in this manner, it should be possible to eliminate mechanical retention at the end of active treatment and have a result that would remain stable.

4. Dewey and Anderson⁷ mentioned that approximal contacts are important natural forces of retention. The dental arch has been compared with a masonry arch in which each unit exerts a great passive force to maintain itself and its fellows in alignment. In just the same manner, if a unit of the dental arch is removed or distorted by a faulty restoration, collapse will ensue. All the active muscle forces which are exerted upon the denture from the buccal side are resisted by approximal contacts of the individual teeth.

Waldron³¹ referred to Fig. 2 in order to demonstrate that the resultant force of the occlusal contact of the teeth is an anterior component of force. In order for this component to be effective, however, all the teeth must be in good approximal contact. If migration tendencies of the individual teeth alone are considered, it is found that the molar teeth tend to drift mesially whereas the incisors, cuspids, and premolars all tend to drift distally when proximally unopposed.

Grieve⁹ pointed out that many treated cases have collapsed as a result of having failed to consider this anterior component of force. The first indication of relapse is a tendency to rotation of the mandibular incisors caused by the anterior drive of the buccal segments.

Waldron³¹ employed Figs. 3 and 4 to demonstrate how teeth may be supra-verted, infraverted, or rotated under the influence of the anterior component of force when approximal contact areas are improperly placed. Undesirable postretention change in such a case is almost a certainty.

5. Dewey and Anderson⁷ listed the quantity and quality of the alveolar process as a natural force of retention. Rickets, endocrine disturbances, and other pathologic conditions have a detrimental effect upon the growth of bone.

The trabecular pattern of the bone may be disturbed and its vitality impaired. Such bone is slow to regenerate and repair itself after the movement of teeth, and it furnishes poor support for the teeth after treatment. There is always great danger of relapse in such cases, even where the orthodontic result was good.

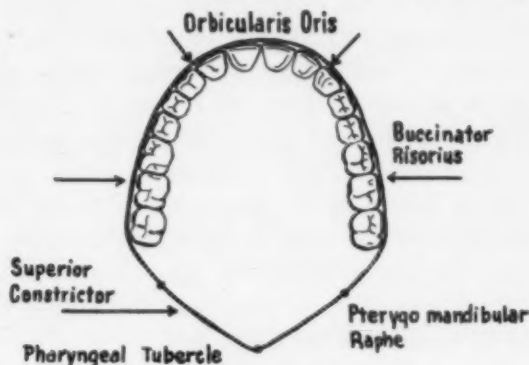


Figure 1

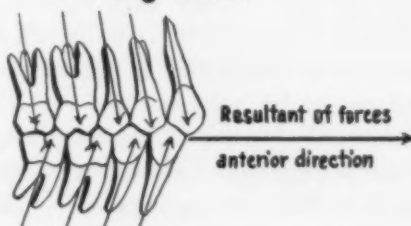


Figure 2



Figure 3

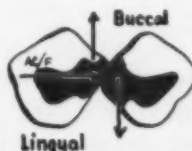


Figure 4

Figures 1 & 2: After A.C. Rohde,
American Journal of Orthodontics
and Oral Surgery, November, 1940

Figures 3 & 4: After G.T. Millietto,
American Journal of Orthodontics
and Oral Surgery, November, 1940

6. Dewey and Anderson⁷ continued the discussion by mentioning condylar relation as a natural force of retention. If the condyle of the mandible is placed in an abnormal relation to the glenoid fossa by orthodontic treatment, relapse will likely occur as the mandible tends to return to its former position. Such cases are seen particularly in Class II malocclusions where intermaxillary elastics or bite planes have been used.

7. Cellular activity was considered by Dewey and Anderson⁷ to be another natural force of retention. Orthodontic treatment causes a certain amount of bone resorption which must be followed by repair. Thus the reparative process must be good if injury, loss of support, and relapse are to be avoided. Webster³²

said that in 1933 Oppenheim pointed out that there is no wholly accurate or satisfactory method of determining the extent of the damage in advance, the amount of repair which will be necessary, or the time required to accomplish such repair following active treatment because these factors differ widely from case to case. For this reason we can never be certain that our efforts will be rewarded with permanent success, or whether relapse is to be expected.

8. Dewey and Anderson⁷ entered controversial ground when they mentioned atmospheric pressure as a natural force of retention. According to them, the air pressure in the nasal cavities and paranasal sinuses is small but continuously active, so that a considerable effect is produced over a period of time. This pressure is a stimulating factor in the balancing of muscular pressure. Mouth breathing upsets this balance not only by causing perverted muscular function, but also by affecting the air pressure in the nasal passages and paranasal sinuses. Hartsook¹¹ took exception to this view and stated that he believes that such an effect would be quite minute indeed.

All of these natural forces of retention are a great aid in insuring permanent success in the treated case if they have been considered in the treatment plan. Conversely, certain of these forces could cause relapse if not regarded. Since these are natural forces, their effect is not only enduring, but functionally essential. If the teeth are to be very rigidly retained in their new positions following active treatment, Waldron³¹ did not believe that the supporting bone would be influenced by the functional demands of the individual. As a result, the posttreatment transformation in the supporting bone takes place much more slowly.

Markus²¹ was of the opinion that it is inaccurate to state that the teeth must be "fixed" following active treatment because this implies that occlusion is static. The positions of the teeth may change immediately, or long after the mechanical retentive appliances are removed. Waldron³¹ suggested that a removable retainer which allows a maximum of functional freedom to the denture, while at the same time providing the necessary minimum retentive restraint, is the best form of appliance.

Waldron³¹ believed that it is advisable to overtreat certain types of cases in order to allow for the gradual transformation of the new bone which is changing its structural form during the period of retention.

Waldron³¹ quoted Mershon who maintained that no form of artificial retention is required after a patient has been treated in such a manner that adjustment of the tissues is permitted through functional adaptation, aided by periods of rest with removal of appliances. The orthodontist can move teeth wherever he thinks they belong, but Nature will reposition them where they are best adapted to the functional needs of the organism as a whole.

In conclusion, Hellman¹³ pointed out that the eventual success of any orthodontic case is dependent upon the establishment of a well-defined goal and the determination for attaining it. Willingness to "let nature do the rest" should be accepted only after every effort has been made by the orthodontist to do all within his power to achieve the best possible results.

SUMMARY

1. The possibility that the teeth of the orthodontic patient would return to their former positions has faced the orthodontist from the beginning, but no means of preventing it has been discovered.

2. The prime requisites for the permanent success of a treated case are correct diagnosis, proper treatment planning, and the attainment of a satisfactory result before retention is considered.

3. Orthodontic results are more stable in cases where treatment is instituted during periods of active growth. Growth accounts for many of the changes seen during treatment.

4. The use of mild, intermittent forces in treatment yields a more satisfactory result because it is only in this manner that resorption and repair can keep pace with tooth movement.

5. Most authorities agree that orthodontic treatment does not produce growth of the basal bone, and that the teeth must be placed in their proper relationships to the basal bone if permanency of the result is to be enjoyed.

6. The natural forces of retention must be considered when the treatment is planned. If this is not done, the forces of retention may well become forces of relapse.

7. The orthodontist moves the teeth into the relationships which he considers to be correct, but Nature eventually repositions them where they can best serve the patient. The ability to perceive the will of Nature is the basis upon which permanent success rests.

REFERENCES

1. Broadbent, B. Holly: The Influence of the Third Molars on the Alignment of the Teeth, *AM. J. ORTHODONTICS AND ORAL SURG.* 29: 312-330, 1943.
2. Brodie, Allan G.: Does Scientific Investigation Support the Extraction of Teeth in Orthodontic Therapy, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 445-460, 1944.
3. Brodie, Allan G., Downs, W. B., Goldstein, A., and Myer, E.: Cephalometric Appraisal of Orthodontic Results: A Preliminary Report, *Angle Orthodontist* 8: 261-265, 1938.
4. Cole, H. J.: Certain Results of Extraction in the Treatment of Malocclusion, *Angle Orthodontist* 8: 103-113, 1948.
5. Coleman, Robert E.: The Equilibration of Occlusion in Orthodontics, *AM. J. ORTHODONTICS* 34: 791-811, 1948.
6. Corlett, E. L.: Mandibular Incisor Position Relative to Basal Bone, *AM. J. ORTHODONTICS AND ORAL SURG.* 33: 21-29, 1947.
7. Dewey, Martin, and Anderson, George M.: *Practical Orthodontics*, ed. 6, St. Louis, 1942, The C. V. Mosby Company, pp. 498-514.
8. Fischer, Bereu: Retention: A Discussion of Permanency of Results in Orthodontic Practice, *AM. J. ORTHODONTICS AND ORAL SURG.* 29: 5-17, 1941.
9. Grieve, George W.: Anatomical and Clinical Problems Involved Where Extraction Is Indicated in Orthodontic Treatment, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 437-443, 1944.
10. Grieve, George W.: The Stability of the Treated Denture, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 171-195, 1944.
11. Hartsook, Joseph T.: Mouth Breathing as a Primary Etiologic Factor in the Production of Malocclusion, *J. Dent. Children* 13: 91-94, 1946.
12. Hellman, Milo: Fundamental Principles and Expedient Compromises in Orthodontic Procedures, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 429-436, 1944.
13. Hellman, Milo: Orthodontic Results Many Years After Treatment, *AM. J. ORTHODONTICS AND ORAL SURG.* 26: 843-853, 1940.
14. Hemley, Samuel: *Fundamentals of Occlusion*, Philadelphia, 1944, W. B. Saunders Company, pp. 328-353.

15. Howes, Ashley E.: Case Analysis and Treatment Planning Based Upon the Relationship of Tooth Material to Its Supporting Bone, *AM. J. ORTHODONTICS AND ORAL SURG.* 33: 499-533, 1947.
16. Krogman, W. M.: Growth Theory and Orthodontic Practice, *Angle Orthodontist* 10: 179-191, 1940.
17. Lewis, Samuel J.: The Treatment of Malocclusion of the Teeth in the Light of Newer Knowledge, *AM. J. ORTHODONTICS* 34: 320-344, 1948.
18. Litowitz, Robert: A Study of the Movements of Certain Teeth During and Following Orthodontic Treatment, *Angle Orthodontist* 18: 113-132, 1948.
19. Madsen, Blair C.: The Diagnosis and Correction of Functional Malocclusion. Read before the Annual Meeting of the A. A. O. held in Louisville, Ky., April 24, 1951.
20. Margolis, Herbert I.: The Axial Inclination of the Mandibular Incisors, *AM. J. ORTHODONTICS AND ORAL SURG.* 29: 571-594, 1943.
21. Markus, M. B.: A Review and Consideration of the Problem of Retention, *AM. J. ORTHODONTICS AND ORAL SURG.* 24: 203-212, 1938.
22. Moyers, Robert E., and Bauer, Joseph L.: The Periodontal Response to Various Tooth Movements, *AM. J. ORTHODONTICS* 36: 572-580, 1950.
23. Noyes, Frederick B.: Histology of Bone Related to Orthodontic Treatment, *AM. J. ORTHODONTICS AND ORAL SURG.* 28: 760-769, 1942.
24. Oppenheim, Albin: A Possibility for Physiologic Orthodontic Movement, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 277-328, 1944.
25. Oppenheim, Albin: Human Tissue Response to Orthodontic Intervention of Short and Long Duration, *AM. J. ORTHODONTICS AND ORAL SURG.* 28: 263-301, 1942.
26. Schaeffer, Aaron: Behavior of the Axis of Human Incisor Teeth During Growth, *Angle Orthodontist* 19: 254-275, 1949.
27. Strang, Robert H. W.: The Fallacy of Denture Expansion as a Treatment Procedure, *Angle Orthodontist* 19: 12-22, 1949.
28. Swinehart, D. Robert: The Importance of the Tongue in the Development of Normal Occlusion, *AM. J. ORTHODONTICS* 36: 813-830, 1950.
29. Sved, Alexander: An Appraisal of Tweed's Basic Principles, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 115-141, 1944.
30. Tweed, Charles W.: Indications for the Extraction of Teeth in Orthodontic Procedure, *AM. J. ORTHODONTICS AND ORAL SURG.* 30: 405-428, 1944.
31. Waldron, Ralph: Reviewing the Problem of Retention, *AM. J. ORTHODONTICS AND ORAL SURG.* 28: 770-791, 1942.
32. Webster, Raymond L.: Retention, *AM. J. ORTHODONTICS* 34: 897-937, 1948.

CERTAIN FACTORS OF ABERRATION TO BE CONSIDERED IN CLINICAL ROENTGENOGRAPHIC CEPHALOMETRY

JACOB B. FRANKLIN, D.D.S.,* MILWAUKEE, WIS.

INTRODUCTION

THE use of roentgenographic cephalometry in orthodontic practice is being recognized more and more as a valuable aid in diagnosis and treatment planning. The original work of Holly Broadbent in 1931 has been followed and developed further by Brodie, Downs, Wylie, and others. These men have developed various kinds of treatment analyses through the use of the roentgenographic cephalostat. It is not within the scope of this paper to describe the methods and procedures followed by these men.

Most of their work has been primarily in the fields of research with definite clinical applications. However, the equipment used by the early investigators was prohibitive in cost for general clinical practice. Some of the refinements of measurement in the cephalostatic equipment are necessary in research for the accumulation of accurate data. However, in making a clinical appraisal in general office procedure, some of the devices of an expensive roentgenographic cephalostat can be dispensed with. It is the purpose of this paper to describe and illustrate an inexpensive setup in an orthodontic office which can be put to good clinical usage, and at the same time to evaluate the limitations and phenomena of roentgenography with its aberrant factors. By recognizing the causative factors which induce these phenomena, one can standardize a technique of cephalometric roentgenography in which certain aberrant factors could be reduced to a minimum, thereby aiding the production of a good roentgenogram. That, of course, leads one into the realm of physics. It is not presumed to take into consideration all the factors which play a role in producing a good roentgenogram. But the orthodontist, if he plans to use the x-ray and cephalostat, should have a working knowledge of the construction of the instruments he is to employ.

THE X-RAY MACHINE

The x-ray machine, in itself, is quite an intricate mechanism. It is not imperative that one must understand the construction of all the parts of this marvelous machine in order to produce a good roentgenogram. However, the productive part, the x-ray tube, should be described to appreciate fully the remarkable powers of this device. It is the source of radiation, producing the roentgen rays or x-rays.

The hot cathode x-ray tube (Fig. 1), developed by Dr. W. C. Coolidge, is the tube used most universally in x-ray machines today. Any good x-ray machine calibrated and capable of delivering up to 30 milliamperes and 90 kilovolts, with a focal spot measurement not exceeding 3 millimeters square, is quite

*Instructor and Head of Division of Clinical Orthodontics, Marquette University; Chief of Staff, Dental Division, Mt. Sinai Hospital.

ample and desirable for this work. Most dental x-ray machines are equipped with tubes which cannot meet such requirements. In addition, most dental x-ray machines have an automatic device which locks the milliamperage and kilovolt output to a predetermined level. This does not allow for manual calibration by the operator. They can be used, however, if necessary, but the exposure time has to be increased proportionately; and this is quite a factor when dealing with young patients. It can be best illustrated by using the milliamperage-time factor. For example, to obtain an output of 60 milliamperage-seconds, a dental machine with a 10 milliamperage capacity would have to be operated six seconds (6×10) to produce 60 milliamperage-seconds of radiation. A 30-milliamperage machine, however, to develop an equal amount of radiation, would operate only one-third the time (2×30) or two seconds to produce 60 milliamperage-seconds of radiation. If it were not for the problem of motion on the part of the subject radiographed, the time factor of exposure would be greatly eliminated, and one could use a low-powered x-ray machine having a small focal spot tube. Cassettes with intensifying screens would not be necessary. Under such conditions, one would get the detail sharpness and definition found in intraoral dental films.

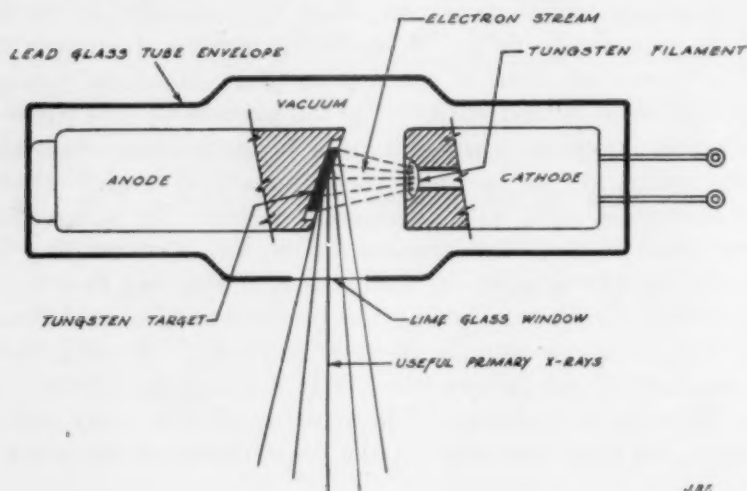


Fig. 1.—X-ray tube.

Of course, this is not possible or feasible. It follows then that a more powerful tube necessitating a larger focal spot will cut down exposure time. In addition, the factor of blurring of the image, due to the movement of the patient, would be greatly eliminated. This advantage is not gained, however, without introducing another disturbing factor, that of diffusion and loss of detail sharpness (Fig. 2).

ROENTGEN RAYS—MILLIAMPERAGE—KILOVOLTAGE

Roentgen rays, named after their discoverer, Professor William Konrad Roentgen, of Bavaria, Germany, have the same speed as light and electric waves, but are of extreme short wave length (Fig. 8). In the electromagnetic wave spectrum, the x-rays are found near the shortest end. Wave lengths are meas-

ured in angstroms, named after the famous Swedish physicist, A. J. Ångström. An angstrom is extremely short and is 0.00000001 of a centimeter (10^{-8} cm.). The symbol for an angstrom is Å. Compare the wave length of visible light which is 4,000 Å to 8,000 Å to roentgen rays which have wave lengths 0.08 Å to 5 Å. When Roentgen discovered them in 1895, he did not know what they were and he called them x-rays. Roentgen rays, like ultraviolet rays and electric rays, are invisible and travel in a straight line. Unlike light rays, they cannot be refracted, focused, or reflected by mirrors. X-rays exhibit the remarkable phenomenon of passing through bodies of various densities. When stopped or slowed down in their passage through dense or very large bodies, the x-rays are absorbed by these bodies. This absorption sets up another phenomenon, secondary radiation (Figs. 6 and 7), which is another disturbing factor to cope with. Further explanation of this phenomenon will be discussed later.

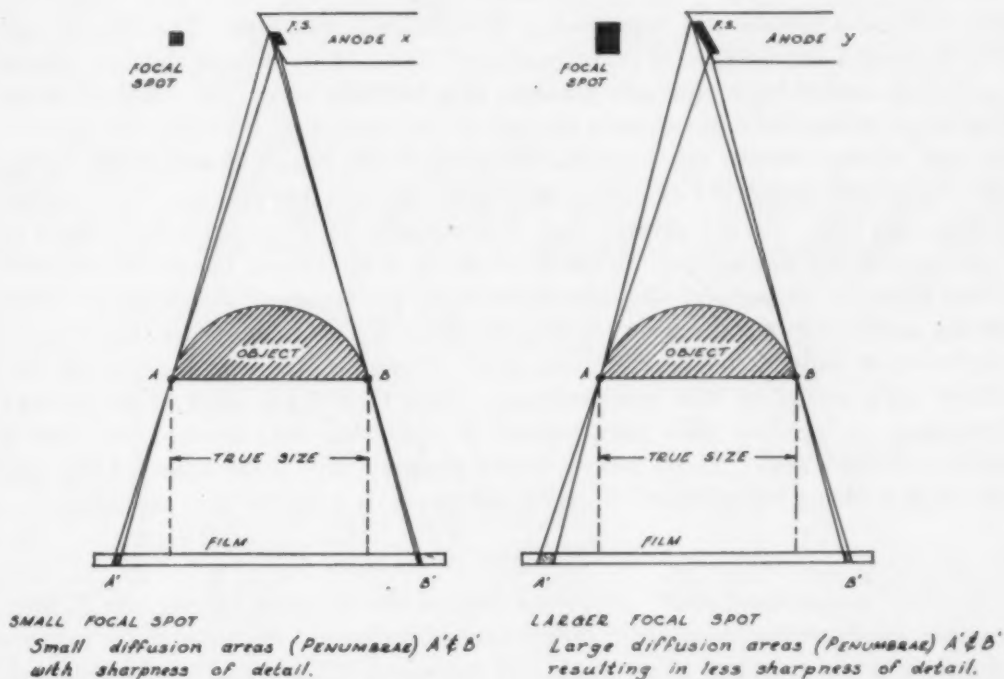


Fig. 2.—Diagrams illustrating projection of points A and B, on an object with x-rays emanating from small and large focal spots.

The amount of electric current passing through a machine or conductor can be measured. The unit of measurement is an ampere. The x-ray machine is so calibrated that it measures these units in milliamperes or 0.001 ampere. Milliampere, during radiation, affects and determines the density of an image on a film; that is, the blackness. The higher the milliamperage, the greater the density. Milliamperes multiplied by seconds of time are called milliampereseconds, the basis of comparison for radiation.

The pressure or electromotive force which drives an electric current through a conductor or wire is measured in units called volts. Because of the tremendous amount of electromotive force necessary to push the electrons across the gap between the cathode and anode of an x-ray tube (Fig. 1), the units employed in roentgenography are kilovolts or 1,000 volts. Kilovolts control the resulting contrast of x-ray films. This contrast is necessary in defining the various densities of a body as they appear on a film. Hence, in penetrating very hard tissues, a high kilovoltage would be required.

THE X-RAY TUBE

The modern x-ray machine is usually equipped with a Coolidge hot cathode tube (Fig. 1) enclosed in a shockproof case. This kind of x-ray tube was developed by Dr. W. D. Coolidge in 1912, and consists of a lead glass bulb from which most of the air has been pumped out to create a pressure of about 0.00001 millimeter of mercury—almost a complete vacuum. Within this tube are two metallic electrodes, the cathode and anode, opposing each other from the opposite ends of the tube and separated a few millimeters apart. The face of the anode toward the cathode is at an angle of 15° to 22° . Within the face of the cathode is embedded a tungsten filament in a focusing cup. The filament, when heated to incandescence, becomes the source of electrons. The electric current, at high voltage, forces the electrons to bombard the target of the anode facing it. The anode, composed of copper and molybdenum, is sealed into the opposite end of the tube. In the slanted face of the anode is embedded a solid piece of tungsten, called the target. When the tube is in operation, the stream of electrons from the filament of the cathode bombard the center of the tungsten target of the anode over a small area. This small area, which is being bombarded with electrons, is called the "actual focal spot." Roentgen rays or x-rays are produced as a result of this bombardment. Less than 2 per cent of the energy necessary to produce this phenomenon is converted into x-rays; the rest is generated into heat. These x-rays, called primary rays, stream out of the tube through a lime glass window incorporated into this tube for that purpose.

THE FOCAL SPOT

The "actual focal spot" area (the area of the tungsten target, Fig. 1, bombarded by electrons) is slightly larger than the filament of the cathode because the face of the target is at an angle (15 degrees to 22 degrees) to the long axis of the tube. This inclination determines the "effective focal spot" of the tube for the rays emanating through the window. The "effective focal spot" size is a determining factor in detail sharpness in radiographic projection (Fig. 2); the smaller the focal spot, the more detail sharpness and less diffusion. Dental x-ray tubes have effective focal spot measurements of 1.3 to 1.8 millimeters square, hence, the sharpness of detail in dental roentgenograms. However, the dental x-ray machine is one of limited power. To subject the dental x-ray tube to a high current intensity would burn out the focal spot of that tube.

To illustrate further the effect of small and large focal spots, let us consider the diagrams in Fig. 2. The anode X has a very small focal spot and the

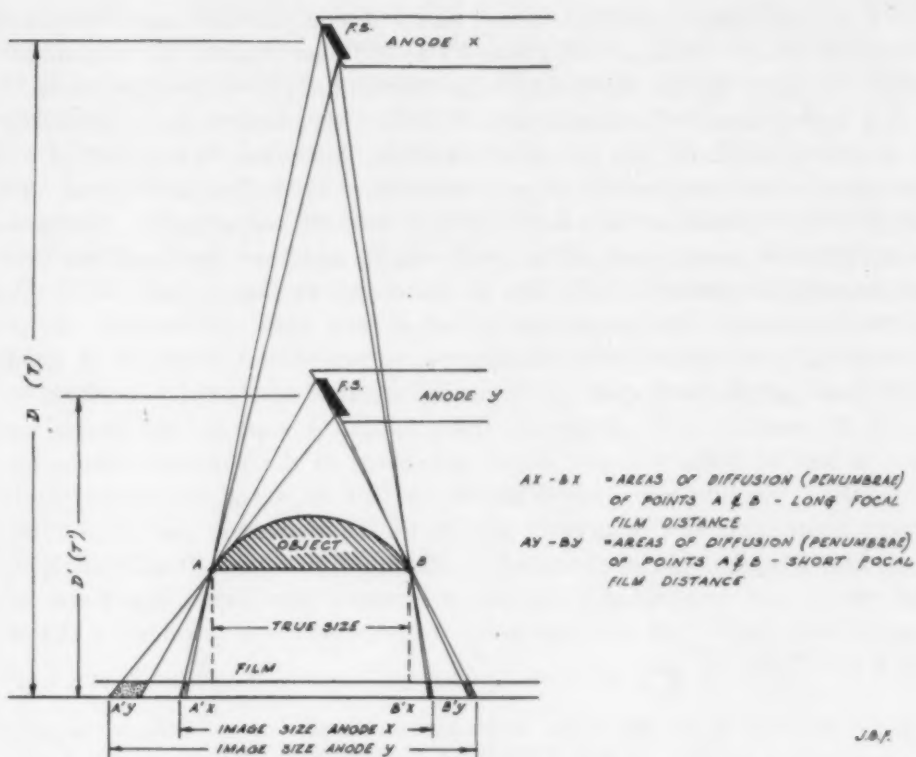


Fig. 3.—Radiographic projection with long and short focal film distances.

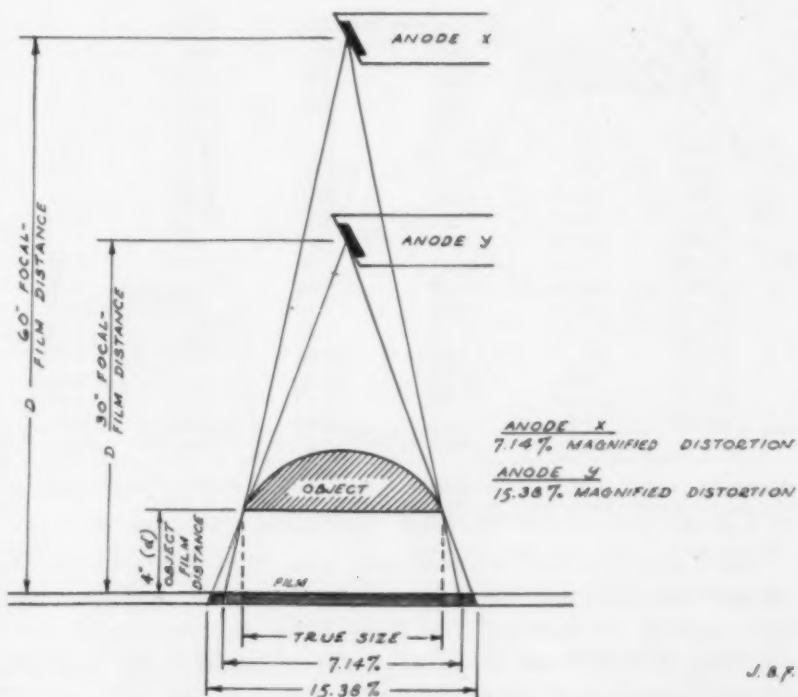


Fig. 4.—Magnification distortion with short and long focal film distances.

anode Y a much larger one. However, anode Y can produce much more x-rays per unit of time. Because the Focal-Film and the Object-Film distances are the same for both anodes, the resultant projected images on the film are of equal size and enlargement. It should be noted that the x-ray images produced by each anode, respectively, are not of equal detail sharpness. The points *A* and *B* of the object radiographed by x-rays emanating from the small focal spot of anode X are projected as very fine points *A'* and *B'*, respectively. The penumbrae or diffusion areas produced are very small, and they represent the over-all roentgenographic quality of the film of the object radiographed. Although enlargement is present, the detail sharpness has been largely preserved. In radiographing the same object with the source of x-rays emanating from anode Y with a much larger focal spot, one can very readily see that the resultant areas, *A'* and *B'*, respectively, projected from points *A* and *B*, are much larger. Hence, a loss of definition and detail sharpness of the resultant image on the film results. Fortunately, this diffusion or lack of detail sharpness produced by large focal spots can be greatly minimized by increasing the Focal-Film distance (Fig. 3). In roentgenographic cephalometry, a long Focal-Film distance is necessary and important. Besides improving the detail sharpness of an image, a long Focal-Film distance helps to decrease the magnification distortion (Fig. 4 and Table I).

TABLE I. PERCENTAGE OF MAGNIFIED RADIOGRAPHIC DISTORTION AT VARYING OBJECT-FILM AND FOCAL-FILM DISTANCES

OBJECT-FILM DISTANCE IN INCHES	FOCAL-FILM DISTANCE IN INCHES						
	24	30	36	42	48	54	60
1.00	4.34	3.76	2.85	2.43	2.12	1.88	1.69
1.25	5.49	4.34	3.59	3.06	2.67	2.36	2.12
1.50	6.66	5.26	4.34	3.70	3.22	2.85	2.56
1.75	7.86	6.19	5.10	4.34	3.78	3.34	3.00
2.00	9.05	7.14	5.88	5.00	4.34	3.86	3.44
2.25	10.34	8.14	6.66	5.66	4.91	4.34	3.89
2.50	11.62	9.09	7.46	6.32	5.49	4.87	4.36
2.75	12.94	10.09	8.27	7.00	6.07	5.36	4.80
3.00	14.28	11.11	9.09	7.69	6.66	5.88	5.26
3.25	15.66	12.15	9.99	8.38	7.26	6.40	5.72
3.50	16.27	13.20	10.76	9.10	7.86	6.93	6.19
3.75	17.64	14.28	11.62	9.79	8.70	7.33	6.66
4.00	20.00	15.38	12.50	10.52	9.09	8.00	7.14
4.25	21.51	16.50	13.38	11.25	9.71	8.54	7.62
4.50	23.07	17.69	14.28	12.00	10.34	9.09	8.10
4.75	24.67	18.81	15.20	12.80	10.98	9.64	8.63
5.00	26.31	20.00	16.12	13.51	11.62	10.20	9.09

FOCAL-FILM DISTANCE

The Focal-Film distance is measured from the center of the focal spot (target) of the anode to the film. In roentgenographic cephalometry, the distance mostly used is 60 inches. The Focal-Film distance, as shown diagrammatically in Fig. 3, where we have two x-ray tubes of equal potential and of equal sized focal spots represented by anodes X and Y, the Focal-Film distances are represented as *D* and *D'*, respectively. X-rays emanating from the focal

spot of anode X , through points A and B , create small image areas of diffusion (penumbrae) AX and BX , respectively. However, when the Focal-Film distance is materially reduced as shown by D' of anode Y , the areas of diffusion (penumbrae), AY and BY are proportionately increased over areas AX and BX , respectively; and, thereby, further reducing the detail sharpness or definition. In addition, it must be remembered that the exposure time requirement necessary to radiograph a body at various Focal-Film distances varies directly proportionately to the square of the Focal-Film distances. For example, in Fig. 3, D (T) and D' (T') represent the Focal-Film distance and time exposure for x-rays emanating from anodes x and y , respectively. If the Focal-Film distance, D , of anode X is 60 inches, and that of D' of anode Y is 30 inches, and the exposure time is three seconds for anode X , then by utilizing the formula:

$$T : T' :: (D)^2 : (D')^2$$

or

$$3 : T' :: (60)^2 : (30)^2$$

$$T' = \frac{3}{4}$$

We find T' , the exposure time from anode Y , is three-fourths second, although the Focal-Film distance is only one-half of anode X .

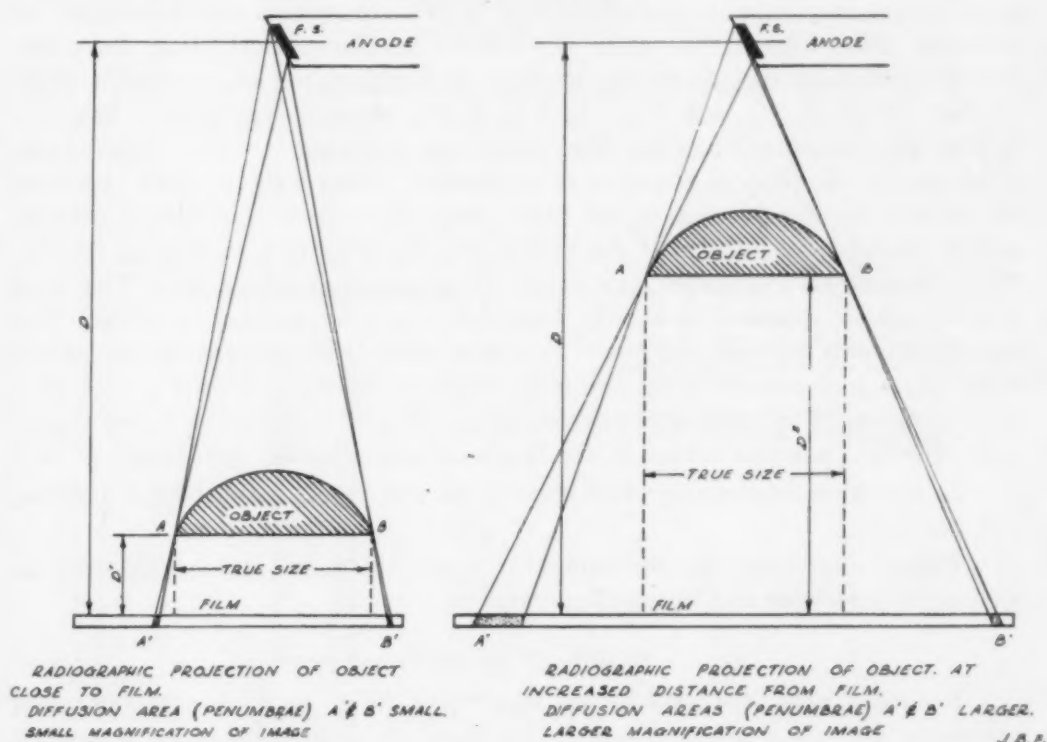


Fig. 5.—Radiographic projection with long and short object-film distances.

The Focal-Film distance is also a factor in magnification distortion of an image (Fig. 4). Of course, it is not possible to get a true rendition of an x-ray image of an object on a film without some magnification because the body being

radiographed cannot be contained in the same plane of the film. This magnification is a distortion of detail. However, the greater the Focal-Film distance (and the shorter the Object-Film distance [Fig. 5]), the less magnification distortion of the image. This magnified radiographic distortion can be computed mathematically as shown in Fig. 4 and Table I. The percentage of distortion can be determined by using the formula:

$$\frac{D}{D-d} - 1 \times 100 = \% \text{ of magnified distortion}$$

D = Focal-Film Distance

d = Object-Film Distance

OBJECT-FILM DISTANCE

The distance from the object radiographed to the film is called the Object-Film distance, and is also a very important factor in aberration of detail sharpness.

In Fig. 5, the effective focal spot and Focal-Film distance, D , is constant. The Object-Film distances D^1 and D^2 are variable, with D^2 greater than D^1 . Notice the projected areas of diffusion, A' and B' , of points A and B made on film by Object-Film distances D^1 and D^2 . In addition, the magnification radiographic distortion adds to the aberration of detail sharpness and definition. A practical illustration of the effect of Object-Film distance on detail sharpness and magnification distortion can be seen in x-rays taken of a metallic soup strainer (Figs. 9, 10, and 11). In Fig. 9, the strainer was placed with the bottom wire meshing upon the film when radiographing it. The Object-Film distance was as short as could be accomplished. Notice the fineness of detail of the wire mesh very close to the film. The strainer was then turned around and so placed on the film that the bottom wire meshing now created an Object-Film distance of $1\frac{1}{2}$ inches, the depth of the strainer (Fig. 10). The wire meshing which appeared so clearly defined is now hazy and not so sharp. The experiment was carried further. The wire mesh strainer was radiographed about eight inches away from the film, creating an Object-Film distance of 8 to $9\frac{1}{2}$ inches. The resultant roentgenogram (Fig. 11) shows much less sharpness of detail, but also brings in the factor of magnification distortion.

In the three roentgenograms (Figs. 9, 10, and 11), the Focal-Film distance was the same.

Table I computes the percentage of magnified radiographic distortion at varying Object-Film and Focal-Film distances.

SECONDARY RADIATION

Roentgen rays produced by an x-ray tube (Fig. 1) during radiographic operation are called primary rays. They have the unique property of passing through a body to cast an image on a film, but some of these rays are absorbed by the body and surrounding area. This phenomenon of absorption sets up foci of "miniature x-ray tubes" within the body radiographed which in turn send out rays of various wave lengths in different directions. These are called secondary rays (Figs. 6 and 7). Some of these rays are directed toward the film and

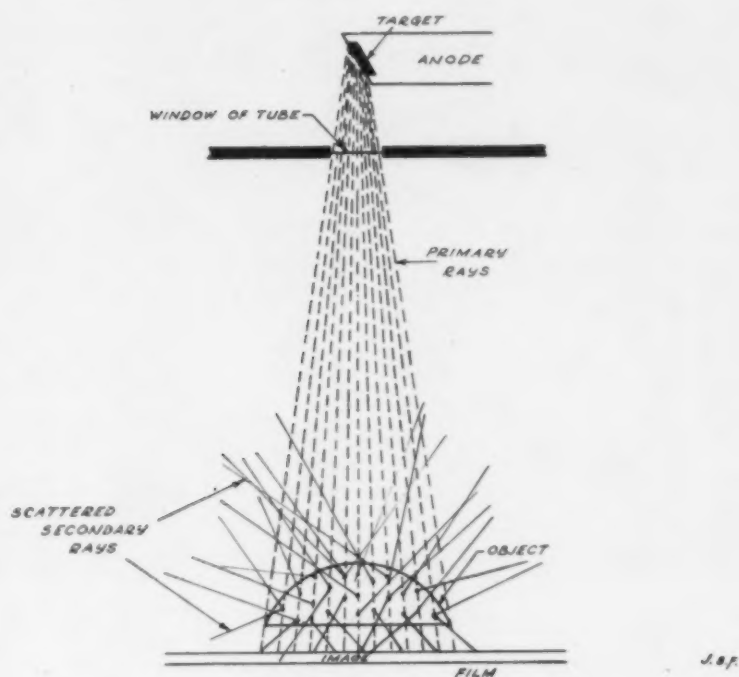


Fig. 6.—Diagram showing radiation without restricting device.

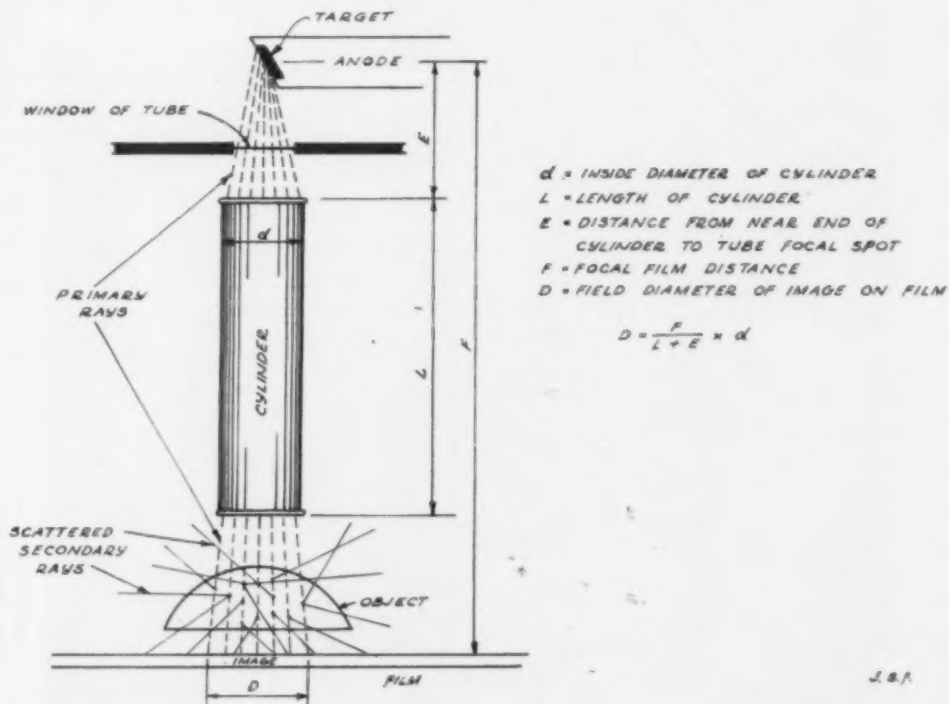


Fig. 7.—Diagram showing radiation restricted with a cylinder.

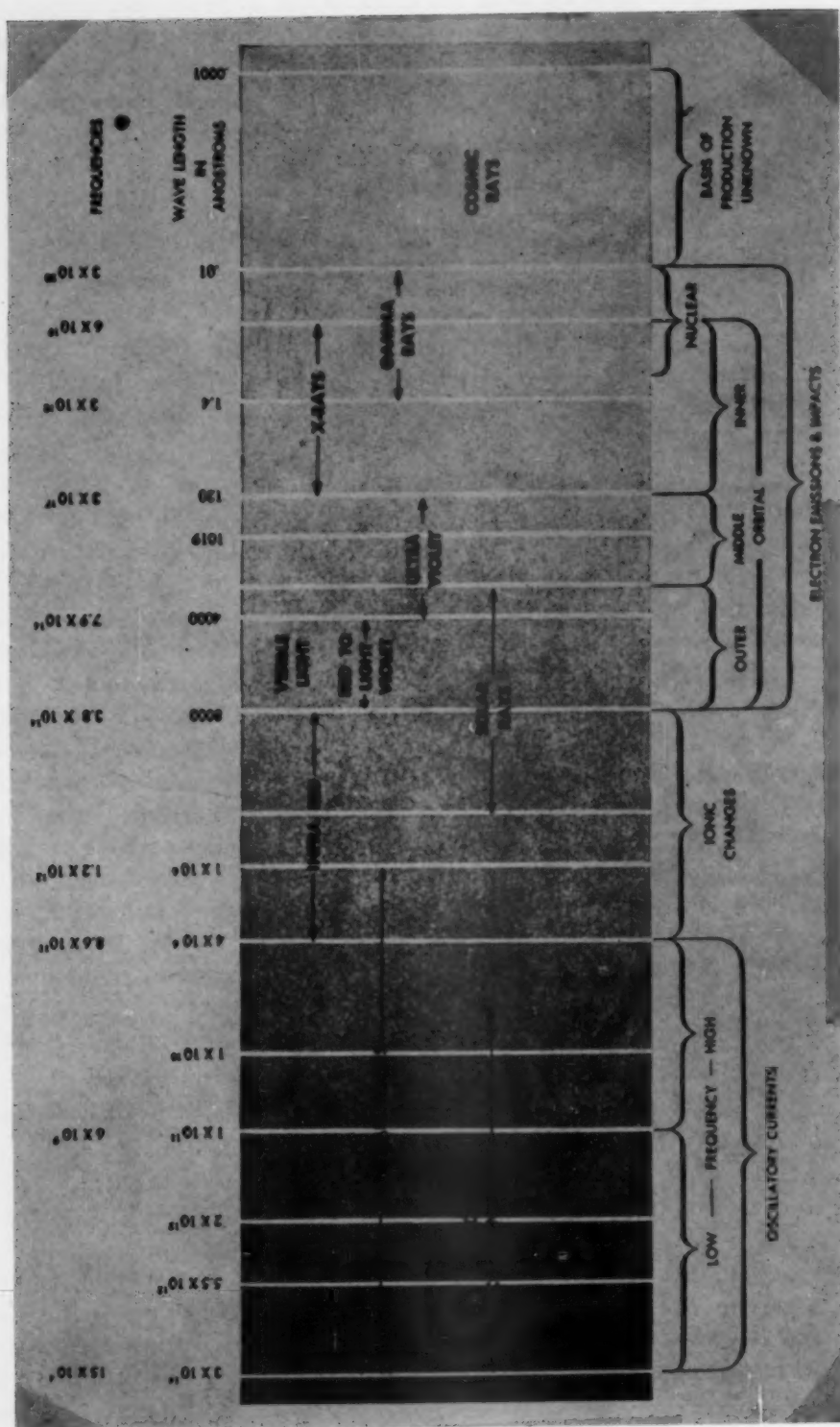


Fig. 8.—Electromagnetic wave spectrum. (From Military Roentgenology, December, 1944.)
 Angstrom is a unit of wave length. (Named after A. J. Angström, Swedish Physicist.)
 One Angstrom (A) = 0.0001 Micron = 0.00000001 centimeter (10^{-5} CM). Visible light wave length 4,000 A - 8,000 A; roentgen rays wave length, 0.08 A - 5 A.



Fig. 9.

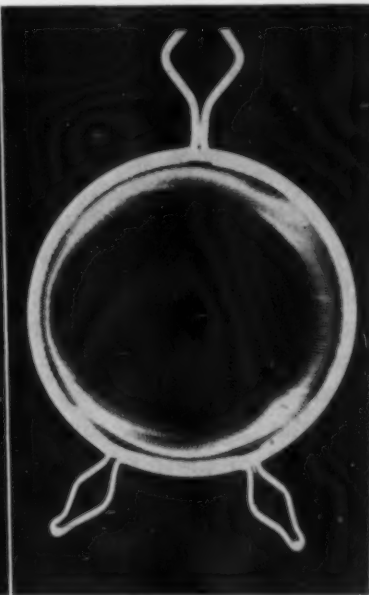


Fig. 10.



Fig. 11.

Fig. 9.—X-ray of metal wire strainer. Bottom end placed on film. Note fine detail sharpness of wire mesh closest to film. Object-Film distance, extremely short.

Fig. 10.—X-ray of metal wire strainer. Bottom end reversed from that of Fig. 9. Wire meshing shows loss of detail sharpness. Object-Film distance, about $1\frac{1}{4}$ inches.

Fig. 11.—X-ray of metal wire strainer. Entire strainer placed 8 inches from film. Compare detail sharpness with Figs. 9 and 10. Added factor of radiographic magnification distortion.

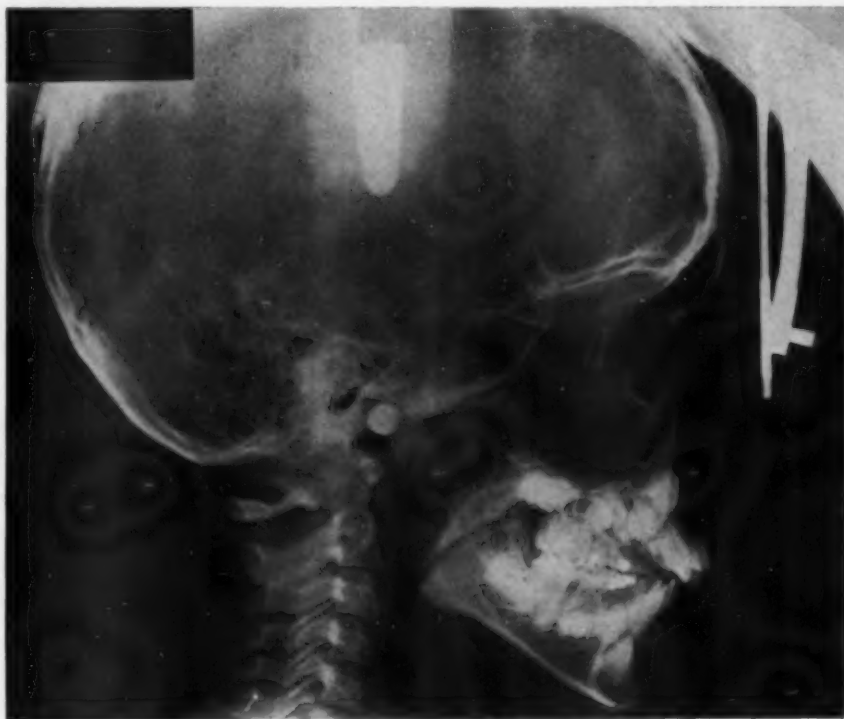


Fig. 12.—Lateral roentgenogram. Limited radiatized circular area produced with use of cylinder. Note effect of secondary radiation beyond circular area.

produce a fogging, thereby obscuring, in effect, the detail sharpness of the image. It is understandable that the greater the total mass and area of the body under radiation, the greater the factor of secondary radiation. This is an important consideration in cephalometric radiography when one considers the size and mass of the human head. By reducing the beam of primary x-rays, and limiting these rays to the anatomical part desired, the "fogging" effects of secondary radiation could be reduced to a minimum (Figs. 7 and 12). Several devices such as cones, cylinders, diaphragms, and grids help limit the effects of secondary radiation by limiting the area of primary radiation. In orthodontic roentgenographic cephalometry, the area for radiation can be limited to a circular area of 8, 9, or 10 inches in diameter, depending on the size of the head (Fig. 12). It is not necessary to radiograph that portion of the cranium above the sella turcica and nasion and below the chin point. Using the ear point (porion) as the center of a circle, a radius of 4, $4\frac{1}{2}$, or 5 inches will cover an area for radiation of the

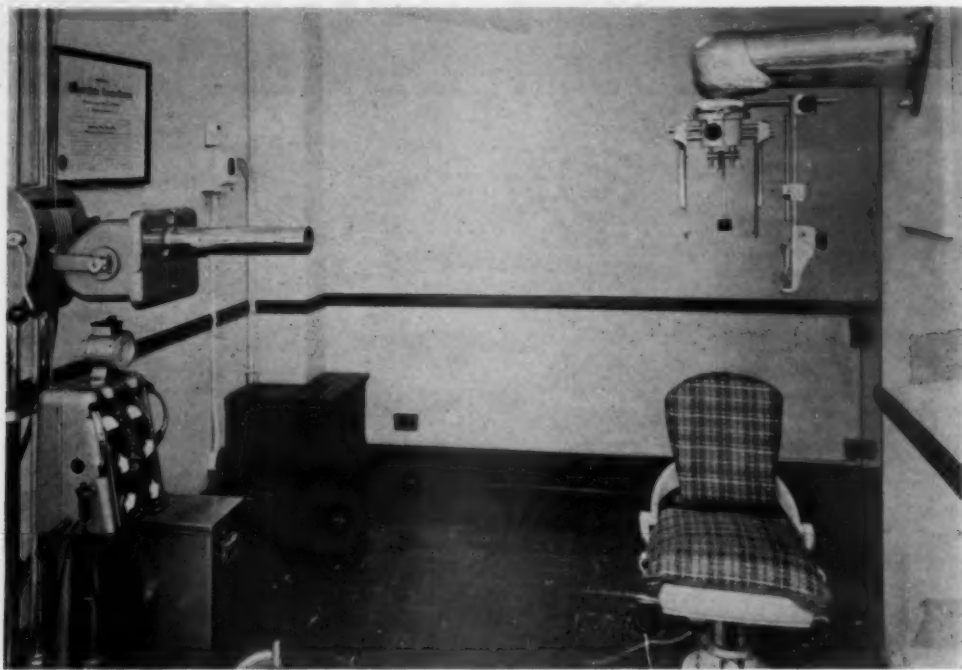


Fig. 13.—Photograph of author's roentgenographic cephalometric equipment.

head sufficient to include all points for measurement. This can be accomplished with the use of a limiting device such as a cylinder (Figs. 7 and 13). An extension or contracting device could be incorporated into this cylinder so that the desired areas for radiation could be varied, depending on the size of the head. As indicated in Table II, the length and diameter of the cylinder to cover areas of diameters of 8, 9, and 10 inches can be computed. The lateral head plate (Fig. 12) was taken at a Focal-Film distance of 60 inches with the aid of a cylinder (Fig. 13). The limited area of radiation produced by the cylinder was a 10-inch diameter circular area. An 8 by 10 cassette with Patterson Par-Speed intensifying screens was used. The exposure time was 1.8 seconds at 30 milliamperes ($30 \times 1.8 = 54$ milliamperere seconds) and 60 kilovolts. (The

TABLE II. MEASUREMENTS IN INCHES

INSIDE DIAMETER OF CYLINDER	2			3			4			5			DISTANCE OF NEAR END OF CYLINDER TO FOCAL SPOT DIAMETER OF IMAGE ON FILM
	8	9	10	8	9	10	8	9	10	8	9	10	
2	13	11.2	10	20.5	18	16	28	24.7	22	35.5	31.3	28	Length of cylinder at focal-film distance of 60 inches
2.5	12.5	10.8	9.5	20	17.5	15.5	27.5	24.2	21.5	35	30.8	27.5	
3	12	10.3	9	19.5	17	15	27	23.7	21	34.5	30.3	27	
3.5	11.5	9.8	8.5	19	16.5	14.5	26.5	23.2	20.5	34	29.8	26.5	
4	11	9.3	8	18.5	16	14	26	22.7	20	33.5	29.3	26	
4.5	10.5	8.8	7.5	18	15.5	13.5	25.5	22.2	19.5	33	28.8	25.5	
5	10	8.3	7	17.5	15	13	25	21.7	19	32.5	28.3	25	

author is now experimenting with a high kilovoltage technique, thereby greatly reducing the milliamperes-second radiation and time factors.) Although the roentgenogram indicates clearly the demarcation of the area affected by the primary rays, it can be observed, however, the effect of secondary radiation on the film beyond the circular area. It should also be noted that had the focal spot of the tube been very small (Fig. 2), and the film not affected by some secondary radiation and fluorescence of the intensifying screens, the outer limits of the circular area would have been very sharp, indeed.

X-RAY HOLDERS

Cardboard holders or cassettees with intensifying screens may be used in roentgenography. The cardboard holder contains no intensifying screens, but is composed of two pieces of x-ray transparent cardboards hinged together with a binding material into which the film (should be a nonscreen film) is placed. The back of this cardboard holder, the side away from the tube, is lined with a thin layer of lead foil, acting as backstop to the x-rays. Essentially, this is the same construction as a dental film packet. In roentgenographic cephalometry, where the Focal-Film distance is quite long, the use of cardboard holders is not practical because the exposure time required would be too great. There would also be the additional danger of x-ray radiation to the patient and the operator. Movement of the patient would cancel out any advantage of detail sharpness. The answer, of course, is a holder with an intensifying apparatus which will help to decrease the exposure time. Cassettes, with intensifying screens, are available for various film sizes. The intensifying screens come in various speeds. Where extremely short exposure time is necessary, the high speed type is used. Better definition or detail sharpness is obtained with slower speed screens. The use of intensifying screens helps to shorten the exposure time to a fraction of that required for cardboard holders. Each cassette holder, hinged like a cardboard holder, but composed of Bakelite and metal cover, contains two intensifying screens. The Bakelite cover, facing the x-ray tube, is transparent to x-rays. Also, the screen facing the tube is thinner than the rear one to allow for better penetration and less absorption. The intensifying screens are composed of cardboard coated usually with fluorescent crystals of calcium tungstate. The film is placed between the two screens. The film used *must* be a screen film which is sensitive to the fluorescence of the screens. The fluorescent glow of the intensifying screens is produced by the x-rays in its action on the coating of calcium tungstate. The fluorescent action of the screens speeds the action of the x-rays on the screen-sensitive film. Actually the fluorescent glow of the screens has a greater effect on the screen-sensitive film than the primary x-ray beam. It has been shown, experimentally, that density for density, only $\frac{1}{50}$ or 2 per cent of the primary radiation need be used with a screen film and intensifying screens than with a nonscreen film and no intensifying screens. That means that more than 98 per cent of the effect of radiation on a film is produced by the fluorescence of the screens. However, detail sharpness or definition is impaired by the use of intensifying screens.

INSTALLATION OF EQUIPMENT FOR CLINICAL OPERATION

As stated before, an x-ray machine capable of delivering up to 30 milliamperes—90 kilovolts—is desirable. Low-powered machines can be used, but one should remember the time exposure which is such an important factor regarding movement of the patient and in detail sharpness or definition in roentgenograms. The equipment used by the author (Fig. 13) consists of a Fischer x-ray machine calibrated to 30 milliamperes and 90 kilovolts with a 2.8 millimeter square focal spot tube, a Thurow Cephalostat* mounted on a wall, and an adjustable dental chair. There are various cephalostats on the market today which are quite similar. Some are attached to the dental chair and are adjustable to the patient. The x-ray tube in this type of setup must also be adjustable. Both the tube and cephalostat are operated on a track so calibrated that the center beam of x-rays from the tube passes through earposts of the cephalostat before radiographing. The chair, of course, is stationary in height and need not be a dental chair. This type of setup requires two adjustments; hence, the factor of personal error of adjustment. However, in a cephalometric setup wherein the x-ray tube and cephalostat are in a fixed position (Fig. 13), the patient, by means of an adjustable chair, is maneuvered into position. This kind of setup is desirable for it eliminates further probability of human error in adjustment. Regardless of the type of setup, it is well to remember certain basic factors which are desirable in cephalometric roentgenography. The Focal-Film distance should not be less than 60 inches, and the cephalostat should be so constructed that the Object-Film distance during radiation is as short as possible. The surface of the cassette should be at right angles to an imaginary line drawn through the earposts. This is of utmost importance, for any appreciable variation of this relationship will cause a distortion of the image on the film. This can be checked and verified by observing if the left and right earposts appear on the film as superimposed solid or concentric circles.

The designer or manufacturer of each type of cephalostat supplies the necessary directions for its mounting. Generally, the following steps should be observed when setting up equipment wherein the x-ray tube and cephalostat are fixed:

1. The cephalostat should be so mounted that the earposts are at least 30 inches from the lowest position of the adjustable chair and still have ample range for very small children, as well as very tall patients.

2. The x-ray head should be so mounted and fixed that the focal spot is in line with the earposts and at least 60 inches from the midpoint between the earposts. This would assure a Focal-Film distance of slightly more than 60 inches. Any distance shorter than 60 inches is not recommended for roentgenographic cephalometry.

RADIOGRAPHING THE PATIENT

A roentgenographic cephalometric setup of equipment in which the x-ray head and cephalostat are in a fixed position does not necessarily mean complete elimination of movement; and such movement introduces a disturbing

*Designed by Dr. Raymond C. Thurow, Madison, Wis.



Fig. 14.

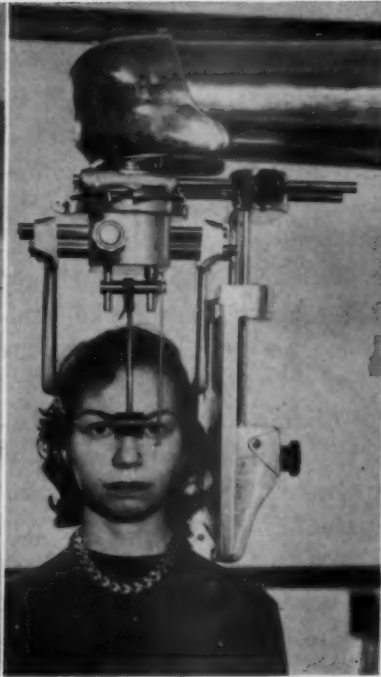


Fig. 15.

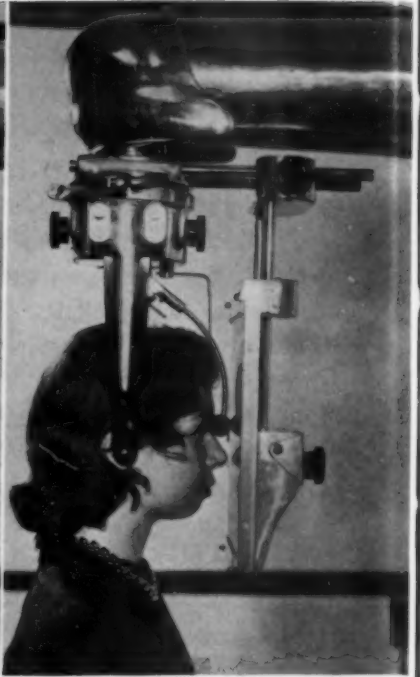


Fig. 16.

Fig. 14.—Position for lateral roentgenogram view of cephalostat facing x-ray machine.
 Fig. 15.—Position for lateral roentgenogram; side view of cephalostat.
 Fig. 16.—Position for anterior-posterior roentgenogram; side view of cephalostat.



Fig. 17.—Tracing table with shadow box,

aberrant factor during radiographic exposure. Slight movement by the patient may be sufficient to blur detail. Although the earposts of the cephalostat exert a deterrent to movement, a slight shiver or body adjustment is possible. For that reason it is imperative, as in the case of young patients, to complete the exposure as rapidly as possible.

In the adjustment of the patient in the cephalostat it is important that he be made as comfortable as possible. He should be seated erect, in an unstrained position, with the ears between the earposts. In adjusting the earposts to the outer ear canals, be sure to make them firm but not too tight. If the earposts are too large in diameter, the patient cannot be adjusted comfortably. In addition, the designation of porion on the roentgenogram in determining Frankfort horizontal may not be as accurate as one may wish. There is also an advantage in having a cephalostat with interchangeable earposts, one pair for older patients and another, a smaller diameter, for young patients.

The exposure time of radiation varies with the age and size of the head of the patient. There is an additional variable factor: the radiation output per second of the x-ray tube used. For that reason, experimentation by the operator will determine the best milliamperage-kilovoltage and exposure time of the particular x-ray machine for each patient group.

SUMMARY

1. The type of x-ray machine is an important factor in roentgenographic cephalometry because of the long Focal-Film distance involved. A more powerful x-ray machine than a dental x-ray machine is desirable.

2. The milliamperage is a factor in radiation for milliamperage determines the density in a roentgenogram. The kilovoltage is another factor in radiation. The higher the kilovoltage, the greater the contrast of an image on a film. An x-ray machine should be calibrated so that the operator can control the milliamperage and kilovoltage. Such control is usually not incorporated in a dental x-ray machine.

3. *The focal spot:* The smaller the focal spot, the finer the detail sharpness and definition of the image on the film; and, contrariwise, the larger the focal spot the less sharpness of detail. However, this factor can be greatly minimized by a long Focal-Film distance. A tube equipped with a small focal spot has less capacity for the amount of radiation delivered per unit of time exposure than a tube with a larger focal spot. This is an important factor where the Focal-Film distance is long as it is in roentgenographic cephalometry. Radiation varies directly with the square of the distance.

4. The Focal-Film distance is a factor in detail sharpness and magnification distortion in roentgenograms. The longer the Focal-Film distance, the sharper the detail and the less magnification distortion. At least, a Focal-Film distance of 60 inches is desirable in roentgenographic cephalometry.

5. The Object-Film distance is also a factor in detail sharpness and magnification distortion. The shortest possible Object-Film distance will greatly improve definition and minimize, to a marked degree, magnification distortion.

6. Secondary radiation is the causative factor in obscuring sharpness of detail in a roentgenogram. The size and volume of an anatomical part radiographed determines the amount of secondary radiation produced. Limiting devices such as cylinders, cones, and diaphragms attached to the x-ray head concentrate the primary beam of radiation to a particular area of the head to be radiographed. This, in effect, decreases the undesirable aberrant factor of secondary radiation.

7. Cassettes, with intensifying screens, are very necessary in roentgenographic cephalometry. Although they reduce the definition and detail sharpness of a roentgenogram, the gain in the extreme shortness of exposure time more than compensates for loss of definition. Intensifying screens of various speeds determine the factor of time exposure.

8. The kind of equipment set up is another important factor in roentgenographic cephalometry. A setup where the x-ray head and cephalostat are fixed introduces less factors of variability and human error of adjustment than one where the height of the x-ray head and cephalostat are adjusted to the patient. The adjustment of the patient into the cephalostat should be so organized as to produce the least amount of discomfort to the patient. An uncomfortable position of the patient may introduce the undesirable factor of movement.

REFERENCES

- Adams, J. W.: Correction of Error in Cephalometric Roentgenograms, *Angle Orthodontist* 10: 3, 1940.
- Broadbent, B. S.: A New X-ray Technique and Its Application to Orthodontia, *Angle Orthodontist* 1: 45, 1931.
- Broadbent, B. S.: Bolton Standards and Technique in Orthodontic Practice, *Angle Orthodontist* 7: 209, 1937.
- Downs, W. B.: Variations in Facial Relationships; Their Significance in Treatment and Prognosis, *AM. J. ORTHODONTICS* 34: 812, 1948.
- Ennis, L. M.: *Dental Radiology*, ed. 4, Philadelphia, 1949, Lea & Febiger.
- Files, G. W.: *Medical Radiographic Technique*, sixth printing, Springfield, Ill., 1949, Charles C Thomas, publisher.
- Higley, L. B.: Head Positioner for Scientific Radiographic and Photographic Purposes, *INT. J. ORTHODONTIA* 22: 699, 1936.
- Higley, L. B.: Lateral Head Roentgenograms and Their Relationship to the Orthodontic Problem, *AM. J. ORTHODONTICS AND ORAL SURG.* 26: 768, 1940.
- Margolis, H. I.: Standardized X-ray Cephalographics, *AM. J. ORTHODONTICS AND ORAL SURG.* 26: 725, 1940.
- McCall-Wald: *Clinical Dental Roentgenology*, Philadelphia, 1947, W. B. Saunders Company.
- Robertson, J. K.: *X-rays and X-ray Apparatus*, New York, 1924, The Macmillan Company.
- Simpson, C. O.: *The Technic of Oral Radiography*, ed. 2, St. Louis, 1930, The C. V. Mosby Company.
- War Department Technical Manual—Military Roentgenology, 1944.
- Wylie, W. L.: Cephalometric Roentgenography and the Dentist, *AM. J. ORTHODONTICS AND ORAL SURG.* 31: 341, 1945.

208 E. WISCONSIN AVE.

TWENTY-FIVE YEARS' EXPERIENCE WITH THE ZYGOMATIC METHOD

H. BERGER, DR. MED. DENT., TEL-AVIV, ISRAEL

TWENTY-FIVE years ago I first published an investigation into a possible relationship between the bizygomatic breadth and the breadth of the palate. Since then I have touched upon the problem in several publications; but I think after such a lapse of time it might be justified to treat the question once again in a more comprehensive way. This would at the same time give me the opportunity to discuss the tests and reinvestigations to which this method has been subjected meanwhile by different authors.

It will be well to remember that, a quarter of a century ago, cephalometrics was in its infancy, and the Frankfort horizontal plane and the orbital plane were on the agenda. While these planes allowed for an orientation of the denture in sagittal and vertical direction, there was no method available to bring the alveolar arch into relation with the face or head horizontally. For practical purposes the Pont index or the Hawley method was used, and a raphe median plane served for the determination of symmetry. As the above-named methods were based on the breadth of the teeth, it seemed to me highly desirable to establish a cephalometric relation for the dimension of breadth too.

The auspices for my undertaking were not promising. Martin, an authority in the field of anthropology, had categorically stated that it had not been possible to discover a relationship between the width of the palate and the shape of the face. And Franke, who just then had published a comprehensive investigation into the "Growth and Deviation of the Jaws and the Nasal Septum," had had to admit that he could not find a "constant relationship between the breadth of the basis of the skull on the one hand and the width of the jaw and the palate on the other. . . . Not even the bizygomatic breadth is of the least importance for the development of the width of the upper jaw." To the above two remarks could be added the somewhat later statement by Todd that maximum palatal breadth is reached by 10 years of age, while the bizygomatic breadth continues to grow through adolescence, and that therefore a close growth-relationship between palatal and bizygomatic breadth could not exist.

Under these not very encouraging conditions I decided first of all to circumvent avoidable difficulties and potential sources of error as far as possible. Therefore, for the time being, I gave up any attempt to establish a *growth* relationship in order to avoid the certainly more complicated conditions of the period of growth and development, and restricted myself to the

task of finding out whether there existed some relation in the adult. As a further measure of simplification I would not concern myself with comparisons of *shapes* of palate or head. Thus avoiding the pitfalls and spurious conclusions connected with the use of indices, I would hold on to pure measurements of width. It was self-understood that for the oral measurement the first maxillary molars should be used, since these teeth were so prominent in Angle's system. Furthermore, by choosing as points of measurement the centers of these teeth, I gained as an additional advantage the possibility eventually to compare my results with the then prevailing method of Pont which made use of the same points of measurement. As to the extraoral landmarks, the zygomatic arches, in spite of the remarks quoted, seemed to me highly promising, as well as most convenient, since the measurement of the bizygomatic breadth is so easily taken.

It is very difficult indeed not to overrate the connection of the dental apparatus with the zygomatic arches. They serve for the attachment of the masseter, the strongest and most important of the muscles of mastication. The thus exerted downward pull is counterbalanced by the external fascia of the temporal muscle which inserts at the upper rim of the arch. The temporal muscle itself passes through the opening between the arch and the head, and therefore the volume of this muscle, too, should have a certain connection with the shape of the arch and its greater or lesser prominence. Finally, the arch is joined to the maxilla characteristically at the very point where the greatest stress during the masticating process is exerted, i.e., above the first molar. But while in people of the Caucasian race the buccomedial root stands below the insertion of the arch, in primitive people the buccodistal root occupies this place, as Klaatsch has pointed out. Thus the zygomatic arch might be compared to a buttress transmitting and distributing much of the masticatory stress upon the vault of the head. While in these different ways the zygomatic arch shows itself intimately connected with the masticatory system, it is, on the other hand, sufficiently far removed from it and reasonably secure from itself becoming deformed under the influence of possible dental anomalies. I should like to add that in recent years Atkinson has devoted interesting investigations to the zygomatic arch and especially to its insertion in the maxilla, which he calls the *key-ridge* because of its connection with the first molar, the key tooth of the angle system, a very fitting term indeed.

INVESTIGATION IN ADULTS

Progressing from theory to practice, I started the search for a sufficiently great number of adult individuals who could boast of a full complement of teeth as well as of a so-called "normal" occlusion. Scanning the literature, I have found that in investigations of that type only about 5 per cent of the individuals examined are of the required standard, and this when children and juveniles are concerned. It goes without saying that in our present-day civilization the percentage in adults is lower still. These explanations are offered here as an excuse that eventually I contented myself with a mere 30 individuals, a fact that has repeatedly been objected to later

on. I myself thought it a rather unsatisfactory achievement and endeavored to supplement it by an investigation into skulls of different races. Here the yield was 65.

To evaluate the results I used the method of frequency-polygons. I have realized since that the coefficient of correlation is the ideal instrument for such work. In the 30 individuals of European parentage, the mean for the molar distance was 48.1 and that for the bizygomatic breadth, 140.9 mm., i.e., roughly three times the molar distance, the exact third being 46.97 mm. The arrangement of the frequency-polygons showed that in 23 cases (76.6 per cent) the molar distances deviated by not more than 2 mm. from the bizygomatic third. Two millimeters being about 5 per cent of the molar distance, I did not think this a bad result. As to the 65 skulls of different races, the mean was 131.7 mm. for the bizygomatic breadth (43.9 mm. for the third) and 48.3 mm. for the molar distance. The discrepancy between the bizygomatic third and the molar distance in this sample is easily explained by the fact that in the bizygomatic breadth measurement the amount for the thickness of the skin is lacking (about 7 mm.). Besides this the postmortal desiccation affects the outlying parts of the skull like the zygomatic arches more than the central parts. Arrangement of the frequency-polygons demonstrated that in 53 skulls (81.5 per cent) the molar-distances were distributed within ± 3 mm. around a value: bizygomatic third +5 mm. This second investigation therefore corroborated my previous findings and at the same time indicated that the zygomatic-molar relation was not confined to the Caucasian race, but had a wider and more general application.

TABLE I. GROWTH OF BIZYGOMATIC BREADTH AND ALVEOLAR WIDTH

		AGE IN YEARS				GROWTH IN MM.
		2	3	13/14	15	
Smyth and Young	Bizyg. breadth	111.35 (m + f)		125.73 (m) 125.57 (f)		14.38 14.22
	Width at <u>D D</u>	39.94 (m + f)				16.72 16.05
	Width at <u>6 6</u>			56.66 (m) 55.99 (f)		
Woods	Bizyg. breadth		101.15 (m) 98.25 (f)		124.70 (m) 120.58 (f)	24.55 22.33
	Width at <u>C C</u>		30.90 (m) 30.60 (f)			26.05 25.17
	Width at <u>6 6</u>				56.95 (m) 55.79 (f)	

CONDITIONS DURING THE PERIOD OF GROWTH AND DEVELOPMENT

There remained to be seen whether the newly established relation would also hold good for the time of growth or how it could at least be adapted to the changing conditions of the developmental period. We knew that, after the eruption of the first molars, growth of the alveolar width is all but negli-

gible. The bizygomatic breadth on the other hand continues to increase up to the end of adolescence. To get over that discrepancy let us return once more to the connection just mentioned between the insertion of the zygomatic arch and the first maxillary molar. Some years ago the Swiss anatomist Bluntschli called our attention to the fact that this relationship existed in adult individuals only, and that other conditions obtained during the growth period. The alveolar arch develops in a kind of forward translation with regard to the basis of the skull, and during this time there is always the biggest molar to be found below the insertion of the zygomatic arch. Thus at different times the first deciduous molar, the second one, and, finally, the first permanent molar will occupy this place where the strongest masticatory stress will be directly received and transmitted by the zygomatic arch. Thus it may be inferred that the zygomatic-molar relation as found in the adult will, during the period of growth, have a more general character, "molar" always denoting that particular molar which at the given time would be standing below the zygomatic ridge.* Statistical support for this will be found in Table I, which I have compiled for this present publication and which makes use of two valuable investigations, the one by C. Smyth and M. Young, a cross-sectional study of 1,400 children, the other by G. A. Woods, comprising 28 children in a longitudinal study. It will be seen that according to Smyth and Young the bizygomatic breadth increases by 14.38 mm. in boys and 14.22 mm. in girls during the period of investigation. The differences between the alveolar width at $\underline{D}|\underline{D}$ at 2 years of age and that at $\underline{6}|\underline{6}$ at 14 years are 16.72 and 16.05 mm., respectively; thus the two sets of figures are roughly corresponding. The differences according to Woods are 24.55 and 22.33 mm. for the bizygomatic breadth and 26.05 and 25.17 mm. for the alveolar width, and thus they too show a rather parallel development.

TABLE II. MEAN ANNUAL INCREMENTS OF THE BIZYGOMATIC BREADTH (IN MM.)

	BOYS	GIRLS	NUMBER OF CHILDREN INVESTIGATED
Davenport	1.3	1.4	360
Fleming	1.7	1.6	4,491
Goldstein	2.5	—	500
Hellman	1.4	1.6	1,196
Smyth and Young	1.3	1.5	1,400
Woods	1.9	1.8	28
Young, Johnson and associates	1.2	1.5	618
Berger	1.7	1.7	500

On the basis of these figures, we might be tempted to formulate that the bizygomatic breadth is three times the distance between those teeth which are, at a given time, standing below the zygomatic ridge. But even such an assumption would not be of much help for the purposes of orthodontic practice. Therefore, from anthropologic tables, I endeavored to compute the mean annual increment of the bizygomatic breadth and using data about Germans and Swedes (by Rose), Schaffhauser (Schwerz), Hinterpommern (Reuter),

*To explain the underlying causes more clearly, it may be mentioned that in the extremely prognathous baboon the forward translation involves 4 teeth.

St. Louis (Porter), and Worcester (West), I arrived at an amount of 1.5 mm. per year. Thus if in a certain patient use of the bizygomatic breadth method is to be made, we first determine the present value and then add so many times the amount of 1.5 mm. as correspond to the number of years which still separate him from adulthood. At first I took 20 years to be generally the date line. But for some time now I have been using 20 years for boys only and 18 years for girls, whose growth usually comes to an earlier stop. Though with this slight modification the calculation of the expected bizygomatic breadth has proved its worth, I had the curiosity to test the method once more in the light of newer investigations. Therefore I have calculated some mean annual increments of the bizygomatic breadth which are assembled in Table II. If we except the figures of Goldstein which are unusually high, it will be seen that the values range between 1.2 and 1.9 mm. and that 1.5 mm. may well do for practical purposes. Table III shows the growth of the bizygomatic breadth in 500 orthodontic patients; the mean annual increments have been incorporated in Table II.

TABLE III. GROWTH OF THE BIZYGOMATIC BREADTH IN 500 ORTHODONTIC PATIENTS

AGE IN YEARS	BOYS	GIRLS	AGE IN YEARS	BOYS	GIRLS
8	119.6	116.6	14	129.8	127.9
9	120.4	119.3	15	131.8	128.4
10	123.5	120.2	16	135.7	131.7
11	124.4	122.6	17	136.4	132.0
12	124.6	124.5	18	137.1	133.0
13	128.8	126.9			

TESTS AND REINVESTIGATIONS

On the basis of the results described above it was concluded that here we had a method to determine the width of the alveolar arch which would be normal for an individual from a cephalometric point of view. Translated into terms of orthodontic practice, it was stipulated that the zygomatic breadth would serve as a yardstick to determine the proper molar distance and to fix the amount by which to expand in order to bring the teeth into a statistically desirable position. This was a rather pretentious assumption, and it was to be expected that there would be tests and reinvestigations. The first of these took place in Bonn and in Basle. Unfortunately Harth (Bonn) used curves as a means of statistical evaluation. This was not an appropriate method for this purpose, and therefore the verdict was not favorable. Meyer (Basle) on the other hand, though making use of the coefficient of correlation, neglected to calculate the expected bizygomatic breadth, and therefore he, too, came to negative conclusions.

It remained for the thorough and comprehensive study, "Facial Growth in Children," by Smyth and Young to take on the problem in a really competent manner. Based upon material of not less than 1,400 children between the ages of 2 and 14 years, this investigation collected a wealth of information which was worked over in every possible direction and most efficiently presented. One of the items to which special interest was devoted was the zygomatic-molar relation. After criticizing Meyer's publication the authors stated: "In the data collected for the present inquiry the corresponding cor-

relation when corrected for age and based on almost four times the number of observations is definitely significant. . . . It almost reaches 0.5 in the group of normal girls from 8-14 years and almost 0.4 in normal boys in the same age interval. In the group of 95 unselected boys at ages 9-10 years the coefficient is 0.49 and is at least six times its standard error." And after at some length reviewing the Bonn investigation, the authors once more confirmed that the "results of the present investigation which are based on fairly adequate data, show unequivocally that there is a definite correlation between the bizygomatic breadth and the breadth of the dental arches at 6 | 6 in the general population of children. The correlation coefficient remains as high as 0.4-0.5 in all the 3 groups of children examined when the influence of increasing age is eliminated." And in their "Summary and Conclusions" finally, they spoke once more of the "appreciable and significant correlation that obtains between the bizygomatic breadth and the breadth of the dental arches." I think the statements cited speak for themselves and do not need any further comment.

Recently the method has been tested once more in a study about the "Relationships Between Dental Arch Widths and the Width of the Face and Head," by Meredith and Higley. The material consisted of 62 white American children at 5 and 7 years of age. Now my method was originally evolved in adults and in its adaption for children every attempt to determine an individual growth trend had to be abandoned, and, perforce, use had to be made of some statistic device based on average increments of the bizygomatic breadth. The values of the expected bizygomatic breadth must therefore become the more incorrect, the farther back they are to be computed. Under these circumstances it is to be regretted that the authors chose such young children to test the method. As a further source of error would serve the fact that, at least in the 5-year-old, width measurements at E | E only could be obtained and the necessary molar distance had to be estimated. So it is rather

TABLE IV. VARIATION FROM THE AVERAGE RATIO OF MAXILLARY ARCH WIDTH TO UPPER FACE WIDTH (BERGER METHOD) FOR CHILDREN 5-7 YEARS OF AGE
(AFTER MEREDITH AND HIGLEY)

	AMOUNT OF DEVIATION (MM.)					
	0.0-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0
Number of subjects	24	15	12	7	3	1

astonishing that even under these trying conditions the results have been rather satisfactory, at least in my opinion. Meredith and Higley, though, come to the following conclusion: "On the whole, there is a positive association between bizygomatic diameter and width of the maxillary alveolar or dental arch. The extent of association—as indicated by the 8 coefficients based upon samples of 95 subjects or more—appears not to exceed $r = 0.50$. Measurements which 'vary together' only to this extent are not highly related." Since there is quite a discrepancy in our evaluations, may I be allowed to analyze the results from my point of view.

The authors first tested the method by showing the distribution of the differences between the third of the bizygomatic breadth and the alveolar width. Table IV shows the results according to Meredith and Higley. It

will be seen that 39 of the 62 patients had no bigger deviation than ± 2 mm., whereas 51 fell within a range of ± 3 mm. Now, on the average, the molar distance is about 45 mm. A range of 2 mm. for a mean of 45 mm. is 4.4 per cent; a range of 3 mm. is 6.6 per cent. Analyzed in this way, it becomes evident that 39 or 62.8 per cent of the cases deviate from the predicted amount by not more than ± 4.4 per cent, while for 51 or 82.3 per cent the deviation is within ± 6.6 per cent. Taking into account the handicaps described, I rather think that the method has stood up to the test quite well.

The authors then subjected the results to analysis by the correlation coefficient. For 4 groups the respective values were 0.31, 0.33, 0.36, and 0.32. This occasioned the following verdict by the authors: "The relationship is too low to be of practical value to the orthodontist in estimating a child's optimal arch width from his face width." Regarding this remark, I first should like to state that these coefficients of correlation are not accompanied by their standard errors as is the usual procedure. I had the curiosity to compute them and found that all but the last of the coefficients are higher than twice their standard error, i.e., statistically significant, the last one just missing the necessary limit. Now it is certainly open to discussion whether these values, even if statistically significant, warrant the practical application of the tested method. But I should like to mention that the authors also analyzed my previously mentioned investigation of twenty-five years ago (30 individuals with normal occlusion) by means of the correlation coefficient and found $r = 0.88$. This value they characterized as "moderately high." I think that by usual standards such a value in the field of biometrics or cephalometrics should better be described as extremely high, not as moderately so. But if 0.88 is only moderately high, it need not make one wonder if amounts of 0.31 to 0.36 are deemed negligible. As said previously, matters of evaluation are open to discussion, and therefore to strengthen my point I should like to give the word once more to Smyth and Young who on the basis of coefficients of "as high as 0.4-0.5" came to the conclusion that by this is demonstrated "the appreciable and significant association that obtains between the bizygomatic breadth and the breadth of the dental arches." To conclude this chapter I should like to state that until a method better suited for the purpose is developed, and to my knowledge nothing of this kind has happened during the last twenty-five years, nothing speaks against its practical application.

IZARD'S METHOD

It now remains for me a pleasant duty to speak of a "rival" method which evidently was developed at the same time, but which came to my knowledge only a few years after the publication of my investigations. The method of Izard (Paris), though likewise based upon the bizygomatic breadth, differs from mine in the following respects:

1. The thickness of the skin is deducted from the original measurement.
2. As the measurement in the mouth not the mean width at $6 \mid 6$ is used, but the maximum alveolar (interbuccal) width, either at the deciduous molars or, later, at the permanent first or second molars.

3. The ratio between these measurements is 2:1 and remains fairly stable throughout the years.

It is not intended here to enter into a discussion of the different aspects and merits of these two methods. On the whole I think that the method as evolved by me is somewhat easier to employ. Izard, who described both methods in his excellent textbook *Orthodontie* side by side, deals with the question at another occasion in the following manner:

Which method now is to prefer, Berger's or mine? I personally think that both points of relationship in the denture are of equal value and I am inclined to use both methods, as they complement each other. . . . The correction of the bizygomatic breadth as proposed by Berger is excellent and permits in advance to determine the bizygomatic breadth at the age of 20; I wholeheartedly agree with this method.

In my opinion, this is a very fair comment, for which I have always been grateful to Professor Izard.

NEWER OBSERVATIONS

Having up to now described the origin and basis of the method and its fate in the professional literature, there remains to relate how the method fared in my own hands. Employing it in practice, a rather surprising fact emerged more and more clearly through the years. The zygion-molar relation by which it was intended to judge anomalies and to plan their appropriate treatment proved to be normal in the very anomalies themselves to an astonishingly high degree. At that time that was a rather perplexing fact.

TABLE V. MOLAR DISTANCE, BIZYGOMATIC THIRD, AND THEIR CORRELATION COEFFICIENT IN 500 ORTHODONTIC PATIENTS

	MEAN AND STANDARD ERROR	STANDARD DEVIATION AND STANDARD ERROR
Age of sample	m = 11.89 ± 0.111	σ = 2.16 ± 0.063
Molar distance	m = 45.04 ± 0.111	σ = 2.57 ± 0.075
Bizygomatic third	m = 45.02 ± 0.084	σ = 1.87 ± 0.057
Correlation coefficient	r = 0.427 ± 0.037	

My observations were confirmed, when there appeared a study, "Investigations Into the Nature and Characteristic Features of Postnormal Occlusion," by Young, Johnson, Smyth, and Still. This is a kind of sequel to the previously mentioned "Facial Growth in Children," and like this it has been carried out and published under the auspices of the Medical Research Council. Among the results it can be seen that the correlation coefficient for bizygomatic breadth and molar distance in a group of boys with postnormal occlusion is 0.404 ± 0.087 , and thus only slightly lower than that of 0.433 ± 0.089 as found in normal boys of the same age (8 to 9 years). A short while ago I carried out a similar investigation into 500 patients of my own practice. This investigation, however, was not limited to postnormal occlusion cases, but anomalies of all classes were used without any selection. The results as seen in Table V correspond to the previously quoted figures of Young and co-workers. These findings are interesting. But before discussing their importance, I should like to mention another peculiarity of the zygomatic arches which was also proved statistically in the study about postnormal occlusion.

Used to look at orthodontic anomalies from a constitutional point of view, I had realized that the high and narrow leptosomic (asthenic) type with its characteristic angle-profile was predestined for the development of post-normal occlusion. In their study now the investigators found, rather to their surprise, that the children with postnormal occlusion were significantly taller than the normal ones. But though they were taller and though thus their

TABLE VI. DIFFERENCES IN HEIGHT, BIZYGOMATIC BREADTH AND ARCH WIDTH IN BOYS WITH NORMAL AND POSTNORMAL OCCLUSION. (BASED ON FIGURES BY YOUNG, JOHNSON, SMYTH AND STILL)

AGE IN YEARS	DIFFERENCES IN HEIGHT (CM.)	DIFFERENCES IN BIZ. BR. (MM.)	DIFFERENCES IN ARCH WIDTH AT 6 6	
			(MM.)	
8	+3.01	-2.30	-2.97	
9	+4.40	-4.61	-2.76	
10	+3.41	-4.17	-2.53	
11	+5.33	-3.16	-2.44	
12	+3.82	-2.72	-2.33	
13	+4.16	-2.23	-1.74	

bizygomatic breadth correspondingly should be expected to be greater, too, this was not the case and in every group the bizygomatic breadth was smaller, as was the width of the alveolar arches (Table VI). This seeming paradox is easily explained if we call to our mind the picture of the leptosomic type



Fig. 1.

Fig. 2.

Fig. 3.

Figs. 1 and 2.—Girl of leptosomic type with characteristic angle-profile.

Fig. 3.—Extreme angle-profile. Note typical long neck.

(Figs. 1, 2, and 3). Its characteristic features as mentioned previously are its tallness and its narrow build. Therefore, the greater values for height and the smaller ones for bizygomatic breadth are completely in conformity with the constitutional trend and underline the connection of the postnormal occlusion with the leptosomic type once more in a rather astounding way.

As a matter of fact, it was this behavior of the bizygomatic measurement in relation to height which originally called my attention to the importance of the constitutional problem in orthodontics. That the zygomatic arch is really a kind of *index* of the constitutional pattern is stressed by the fact, too, that the correlation between its measurement and weight is greater than that with height, as became apparent in the investigations by Smyth and Young. This connection between weight and bizygomatic breadth, a fact which incidentally can likewise be gathered from Hellman's "wiggles," stresses the importance of the zygomatic arches once more, since weight plays such a decisive part in many indices of constitution. But nothing can show better how strongly and irresistibly the zygon-molar relation asserts itself than the finding that even in children with anomalies the coefficient of correlation was as high as 0.404 and 0.427.

NORMALITY IN THE ABNORMAL

Now there may be asked the question: "What is the use of this relation if it is normal to such a degree even in our patients?" In answering this question I should like first of all to quote a few sentences which Mershon wrote as early as thirty years ago:

There is a certain functional relationship which has grown up among the malposed teeth, the periodontal membrane, the bones supporting them, the muscles of the oral cavity, the tongue, and the circulatory and nervous systems. It is the work of the orthodontist to so remold the maldeveloped bony processes supporting these malposed teeth that harmony will be established in the size and shape of the dental arches and that the malposed teeth may be restored to the position of normal occlusion with proper function and cusp relationship.

And in the same vein:

In a developing child, from the time the permanent denture starts to erupt until it is completed and has developed into a bad case of malocclusion, there is a harmony existing, even in this oral deformity, between the teeth in their malpositions and the tissues and organs which go to make up the oral cavity.

The answer now becomes self-evident: The normality of the zygon-molar relation is but another proof for Mershon's conception. Thus it happened that the most important lesson I received from the practical application of my method was not that it showed me what to do, but rather what not to do: not to expand arches! I am conscious of the fact that this finding is today not of an overwhelming news value. But then it was rather news, and, as far as I know, even today expansion is still widely regarded as a panacea and (this is but another way of stating the same thing) there is still opposition to extraction. But even if we neglect this opposition which anyway will have a difficult stand against the teachings and demonstrations of Tweed and his followers, the problem of extraction is still topical: not in so far as there is a question whether extraction is a legitimate procedure in orthodontics, but in so far as we have to decide in which cases we should extract and in which not, i.e., there is still the question of differential diagnosis.

DIFFERENTIAL DIAGNOSIS

It is really a pity that the protracted struggle between opponents and adherents of extraction has for such a long time diverted so much energy

and thought from this the real problem of extraction: differential diagnosis in extraction cases. And it should be emphasized here most energetically that the considerations regarding extraction do not come under the heading *planning of treatment* but are definitely and necessarily a component part of *diagnosis*. It is up to the differential diagnosis to find out whether there exists a disrelation between the size of the teeth and the supporting bone or whether they are in harmony. The results of such an investigation will influence our decision with regard to extraction. And only after this decision has been made it becomes part of treatment planning to fix which teeth to extract and at what time.

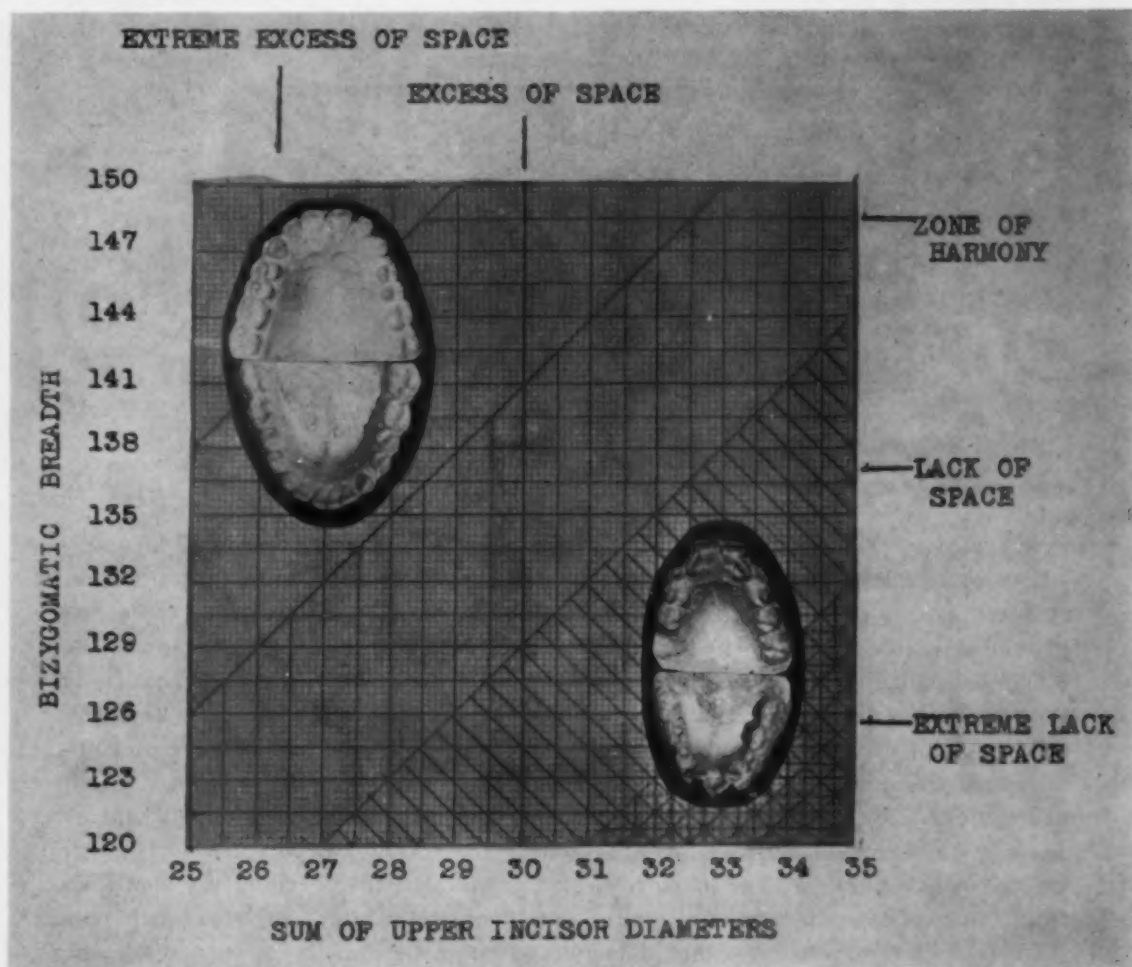


Fig. 4.—Disrelation table.

Now there arises the question whether we have any means to decide whether teeth and bony base are in harmony or not. And here I think that the bizygomatic breadth comes really into its own. Some years ago I published what I called a *disrelation table* (Fig. 4) where horizontally the sum of the widths of the 4 upper incisors is listed, while vertically the values of the bizygomatic breadth from 120 to 150 are recorded. It will be seen that

in the left lower corner both these values are low, whereas in the right upper corner the high values for these measurements are to be found. Between these corners stretches a belt where measurements are more or less in agreement, while to the right of it high measurements of the incisor widths meet with low values of the bizygomatic breadth, and to the left low incisor values coincide with high amounts for the bizygomatic breadth. Thus the nearer we approach the right lower corner, the stronger becomes the lack of space, while toward the left upper corner excess of space is more and more evident. In patients whose values correspond to those in the zone marked *extreme lack of space*, extraction of 4 premolars will not be avoidable. Cases of zone *lack of space* will sometimes profit from extraction on one side only if by such a procedure no asymmetry would be caused, whereas should an asymmetry already exist,

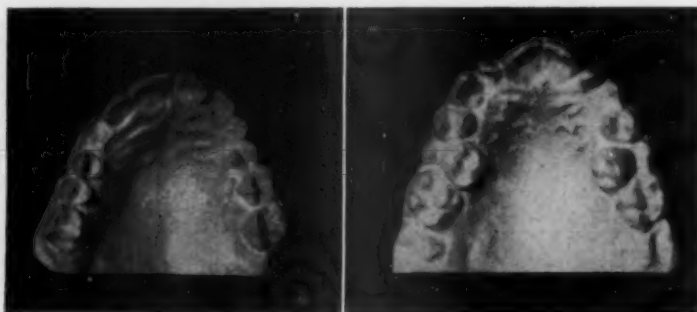


Fig. 5.

Fig. 6.

Fig. 5.—Big incisors counterbalanced by small cuspids and premolars.

Fig. 6.—Disproportionally small lateral incisors.

this would be the method of choice. In anomalies of zone *excess of space* satisfactory closure of the spaces will generally be obtained, while those of zone *extreme excess of space* will defy our efforts. Thus the *disrelation table* has proved its value to me in the last decade, and I am relying more and more on it when diagnosing my cases. But I should like to add a word of caution: though it is a great help, it is not foolproof. There are cases in which the teeth are not of the same pattern as to size. There are occasionally big incisors which at the age of 8 or 9 would indicate a future extraction case but which are matched by surprisingly small cuspids and premolars later on, so that at the age of 11 or 12 an ordinary conservative treatment can be started (Fig. 5). On the other hand lateral incisors are sometimes disproportionately small, so that the resulting incisor sum would not be representative for the tooth pattern (Fig. 6). Here, too, our decision will not be rigidly governed by the *table*, but tempered by a careful weighing of the size of the other teeth. I think, however, that these are minor shortcomings only which with some caution can easily be circumvented.

An interesting method devised to help in the diagnosis of extraction cases is Tweed's use of the Frankfort horizontal-mandibular plane angle. Certainly with the help of the Salzmann maxillator this is an easy and practicable procedure, and I believe that this method is valuable in protrusion cases. But

pure disrelation cases which generally belong to Angle Class I will, in my opinion, be easier analyzed with the help of the *disrelation table*. As this device is an offspring of the zygomatic method I thought it fitting to include it in this review.

REFERENCES

1. Atkinson, S. R.: Orthodontics as a Life Factor, AM. J. ORTHODONTICS AND ORAL SURG. 25: 1133-1142, 1939.
2. Berger, H.: Massbeziehungen zwischen Schaedel- und Zahnbogenbreite (Vorläufige Mitteilungen), Zahnärztl. Rundschau, vol. 35, 1926.
3. Berger, H.: Untersuchungen ueber das Verhaeltnis der Schaedelbreite zur Zahnbogenbreite, Correspondenz-Blatt fuer Zahnärztl., vol. 51, 1926.
4. Berger, H.: Constitution, Heredity, and Orthodontia, AM. J. ORTHODONTICS AND ORAL SURG. 24: 136-150, 1938.
5. Berger, H.: Constitutional Aspects of Orthodontic Problems, AM. J. ORTHODONTICS AND ORAL SURG. 26: 566-583, 1940.
6. Berger, H.: The Problem of Extraction in Orthodontics, AM. J. ORTHODONTICS AND ORAL SURG. 31: 557-582, 1945.
7. Bluntschli, H.: Zur Phylogenie des Gebisses der Primaten, Vrtljschr. der naturf. Gesellsch. in Zurich, vol. 56, 1911.
8. Davenport, C. B.: Postnatal Growth of the Head, Proc. Am. Phil. Soc., vol. 83, 1940.
9. Fleming, R. M.: A Study of Growth and Development, Medical Research Council, 1933.
10. Franke, G.: Ueber Wachstum und Verbildung des Kiefers und der Nasenscheidewand, Ztschr. f. Laryng., Rhin., vol. 10, 1921.
11. Goldstein, M. S.: Changes in Dimensions and Form of the Face and Head With Age, Am. J. Phys. Anthropol., vol. 22, 1927.
12. Harth, G.: Biometrische Untersuchungen ueber die Dimensionen des Normalgebisses in verschiedenen Lebensaltern, Deutsche Monatschr. f. Zahnh., vol. 48, 1930.
13. Hellman, M.: An Introduction to Growth of the Human Face From Infancy to Adulthood, INT. J. ORTHODONTIA 18: 777-798, 1932.
14. Hellman, M.: Some Facial Features and Their Orthodontic Implications, AM. J. ORTHODONTICS AND ORAL SURG. 25: 927-951, 1939.
15. Izard, G.: Orthodontische Diagnostik, Fortschr. d. Orthodontik 3: 224, 1933.
16. Izard, G.: Orthodontie, Paris, 1939, Masson & Cie.
17. Klaatsch, H.: Kraniomorphologie und Kraniotrigonometrie, Arch. f. Anthropol., 1909.
18. Martin, R.: Lehrbuch der Anthropologie, Jena, 1914, Gustav Fischer.
19. Meredith, H. V., and Higley, L. B.: Relationships Between Dental Arch Widths and Widths of the Face and the Head, AM. J. ORTHODONTICS AND ORAL SURG. 37: 193-204, 1951.
20. Mershon, J. V.: Orthodontic Appliances: Their Use and Abuse, J. Nat. Dent. A. 8: 217-220, 1921.
21. Mershon, J. V.: Orthodontia and Its Relation to Dentistry, Dental Cosmos 72: 1292, 1930.
22. Meyer, O. E.: Biometrische Untersuchungen der anatomisch richtigen Okklusion, Deutsche Monatschr. f. Zahnh., vol. 47, 1929.
23. Salzmann, J. A.: The Maxillator: A New Instrument for Measuring the Frankfort Mandibular Base Angle, the Incisor-Mandibular Base Angle, and Other Component Parts of the Face and Jaws, AM. J. ORTHODONTICS AND ORAL SURG. 31: 608-617, 1945.
24. Smyth, C., and Young, M.: Facial Growth in Children, Medical Research Council, No. 171, London, 1932.
25. Todd, T. W.: Facial Growth and Mandibular Adjustment, INT. J. ORTHODONTIA 16: 1243-1267, 1930.
26. Tweed, C. H.: The Frankfort-Mandibular Plane Angle in Orthodontic Diagnosis, Classification, Treatment Planning, and Prognosis, AM. J. ORTHODONTICS AND ORAL SURG. 32: 175-230, 1946.
27. Woods, G. A.: Changes in Width Dimensions Between Certain Teeth and Facial Points During Human Growth, AM. J. ORTHODONTICS AND ORAL SURG. 36: 676-700, 1950.
28. Young, M., Johnson, E., Smyth, C., and Still, M.: Investigation Into the Nature and Characteristic Features of Post-Normal Occlusion, Medical Research Council, No. 225, London, 1937.

In Memoriam

GEORGE R. MOORE

1900-1952

ORTHODONTISTS everywhere were shocked during the week of April 6 to learn of the sudden passing away of Dr. George R. Moore, Secretary of the American Association of Orthodontists. Dr. Moore was one of the best-known orthodontists in America and had been a stalwart worker for the Ameri-



GEORGE R. MOORE.

can Association of Orthodontists for many years. He was a teacher of both graduate and undergraduate orthodontics in the University of Michigan, and had been a member of the faculty of that school since 1924. He was a writer, and since 1938 was the author of the Orthodontic Department of the *Year Book*

of Dentistry. He also lectured in a number of foreign countries, including the Netherlands, the European Orthodontic Society in London, England, and in Mexico and South American countries.

Dr. Moore held many offices in professional organizations. He was active in the American Dental Association, and in addition to that he was elected a fellow of the American Association for the Advancement of Science. He was made honorary fellow of the Mexican Association of Orthodontists, of the Guadalajara Society of Orthodontists, and of the Dental Society of Costa Rica.

Other societies of which he was a member include the Michigan State Dental Society, Washtenaw District Dental Society, Detroit Dental Club, American Association of Dental Schools, International Association for Dental Research, Junior Research Club of the University here, Omicron Kappa Upsilon, Phi Kappa Phi, Phi Sigma, and Federation Dentaire Internationale.

In Ann Arbor, Mich., his home town, he was a member of many organizations. In addition to being professor in orthodontics, an appointment which he received in 1937, he was also research associate in the University Elementary School where he had conducted studies in children's dental development since 1931.

He was born Dec. 24, 1899, in Gibsonburg, Ohio, and attended public schools there. He attended Dennison University in Ohio and received a doctor of dental surgery degree from the University of Michigan in 1923, followed by a master of science degree in 1924. In that year he began teaching in the school of dentistry.

George, as he was affectionately known by his confreres, exerted great influence on the advance of the specialty of orthodontics. He had many students come under his influence and tutorage, and his wholesome character manifested itself on the training of these men all over the world.

Dr. Moore was married to the former Emily Lucile Gould on April 4, 1925, in Gibsonburg. In addition to Mrs. Moore, survivors include a son, Thomas G. Moore, and two daughters, Penelope Ann and Priscilla Jane, the latter a sophomore at Lindenwood College, St. Charles, Mo. Several nieces and nephews also survive.

The American Association of Orthodontists has lost one of its great stalwarts, and he will be missed by his co-workers all over the world. He was president-elect of the Association and would have been president in 1953-1954 had he lived to serve his term of office.

Department of Orthodontic Abstracts and Reviews

Edited by

DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmänn, 654 Madison Avenue, New York City

A Psycho-Somatic Study Into the Nature, Prevention and Treatment of Thumb-Sucking and Its Relationship to Dental Deformity: By A. G. H. Lawes, D.D.Sc., *D. J. Australia* 22: 167-194, April, 1950.

"The habit of thumb-sucking (including fingers or hand) is of great significance both to the psychologist and the dentist and the attempt is made in this paper to survey this problem as a whole. Standardised information has been obtained from over 2,000 children aged 5 years or under, together with detailed case histories of 52 of them. Observations have also been recorded of parallel behaviour in calves.

"Theoretical evidence supported by these practical investigations shows that thumb-sucking is primarily a psychological problem, the treatment of which must conform to accepted psychological principles. It has its origin in the disturbance of an instinctive urge in early infancy, and is broadly divided into two phases, each of which requires different handling, namely the pre-weaning phase and the post-weaning phase. The term pre-weaning means that period, usually from birth to nine months, during which the infant relies almost entirely on the act of sucking to obtain its food, and the post-weaning period refers to the time when the sucking in of food has been discontinued.

"The intention is to accept the proof, which is already available, that thumb-sucking is a potential menace to the dental structures and to proceed to investigate the true nature of the act of thumb-sucking, why it occurs, how it can be prevented, and how it can be treated.

"Not all children who suck their thumbs develop malocclusion. Much depends on the sucking technique and the duration and intensity of the habit as well as whether or not the children in question have well-developed, strongly-built jaw-bones which are capable of withstanding the abnormal pressures brought to bear upon them during the thumb-sucking process.

"No doubt, too, self-correction does take place with some children after thumb-sucking has ceased, provided normal lip, cheek and tongue function still exists, but where this normal function does not exist then self-correction is impossible.

"One of the very first actions of the new-born infant is to suck at his mother's breast, and this too is one of his very first pleasures. This sucking is an instinctive act, and a powerful organic pleasure, with which is soon associated a strong sense of security.

"When a strong instinctive act promotes the first organic pleasures and, at the same time, satisfies the infant's material need for a sense of security, very powerful associations will be built around this act of sucking.

"Some babies suck their thumbs or fingers from birth. There is little doubt that lasting harm can be done to the baby by a too enthusiastic and misguided interference with the act. The continual removal of hand from mouth, the binding of elbows and other forceful methods inflict a terrible sense of frustration. If this sense of frustration becomes associated, as the child grows older, with one or both of his parents, his resentment will remain

always in his unconscious mind and will result in an unbridgeable gulf between parent and child which neither will understand, but which will cause much unhappiness to both.



Fig. 1.



Fig. 2.

Figs. 1 and 2.—Photos of an 18-year-old boy who is still a persistent thumb-sucker. Fig. 1 shows the technique used and Fig. 2 shows the very considerable facial disfigurement resulting from the habit.



Fig. 3.—The same 18-year-old boy and it shows the appalling distortion resulting from thumb-sucking.

“The baby *can* be prevented from getting its thumb to its mouth, but often the price paid is continued nervous strain, mental disturbance and hopeless anger, all of which may spread most harmfully over the whole mental life.

“To lessen the habit and to help the baby grow out of it easily, one must be sure that he is getting full satisfaction at breast or bottle. His attention too must be directed away from his thumb during waking hours by constructive

means, such as giving him more companionship than would otherwise be necessary, and leaving him alone in his cot as little as possible when awake. He should be talked to and have his play shared, such as play with rattle, picking up and throwing down his spoon or toys, and in various other ways occupying him and leaving him as few opportunities as possible to turn in on himself for amusement.

"Thumb-sucking which persists beyond babyhood must be regarded as an infantile habit which still persists. It provides a pleasure faintly echoing that which was enjoyed at the mother's breast and he comes to depend on it more and more for comfort when tired, hungry, bored or emotionally upset. It is claimed that mechanical means are useless, and so, too, are scolding and nagging; for these latter will have the effect merely of driving the child to seek his one sure way of escape and comfort—sucking his thumb. An interesting point, too, is that noted by several other observers; namely, that whilst the thumb is in the mouth all other stimuli remain more or less completely blocked, and objects which usually arouse fear will fail to produce any effect.

"It is further suggested by Faegre and Anderson that the persistence of thumb-sucking in an older child may be his way of obtaining attention from his mother. He may be jealous of a new baby and feel deprived of the attention for which he craves, and to suck his thumb is the one sure way of getting it.

"When thumb-sucking as a habit is well established in later childhood, it usually becomes a means of warding off attacks of various sorts, and it becomes necessary to find out why the child needs a fortress to hide in rather than to try and 'break' the habit itself. As it serves no good purpose to talk to the child about the habit, this should be avoided; otherwise he will revert to it as a defense against criticism. Without substituting some desirable activity to occupy him it is quite hopeless to conquer the habit. Perhaps he has exhausted the possibility of his play things, or has outgrown them, he has no playmates or he needs more attention and affection from his parents.

"The action of sucking, like any other action, can either be reflex, instinctive or purposeful, and it is important to study its exact nature, because upon this will inevitably depend the whole technique of handling the problem.

"The sucking action is undertaken by babies immediately after they are born. No tuition is normally necessary and although some improvement in the actual technique does take place as the infant matures, nevertheless, it is able to suck quite efficiently immediately after birth and in such a way as to derive all its normal nutritional requirements. It is obvious, therefore, that the act is not a voluntary or purposeful one. It operates when a stimulus is applied, but ceases to operate when the stimulus is taken away. It is clear from Martin's descriptions that the sucking act is a purely instinctive one.

"Instead of the infant being satisfied naturally at the breast, he may turn in his search for this satisfaction to his readily available finger or thumb. His sense of security is at its maximum when he lies in his mother's arms while being fed. It can be seen that if he, for any reason at all, should turn to finger-sucking, this will become strongly associated with his sense of security and it has been frequently observed that when young children are in need of comfort they very readily turn to thumb- or finger-sucking. Efforts must be made to see that natural instinctive urges are satisfied in a desirable fashion, and thus will be avoided undesirable modifications.

"If we accept the contention that sucking is a purely instinctive process, then this dictum of McDougall's disposes once and for all of the hope of checking or breaking the thumb-sucking habit by the use of more or less mechanical obstacles such as elbow splints, sticking-plaster, mittens and the like. This explains, too, how it is that children can be subjected to these restrictive procedures for long periods of time without such procedures meeting with the slightest success.

"Roberts disclosed a close relationship between the length of feeding times and the onset of thumb-sucking, and in this way would appear to dovetail in with the contention that not only must nutritional requirements be satisfied, but also that emotional and sensual satisfactions must be met. When feeding time is short, then these latter requirements are unfulfilled and the substitute of thumb-sucking is resorted to. Roberts points out that in general those who were not thumb-suckers enjoyed a longer feeding time than the thumb-suckers.

"It will be readily seen, therefore, that if an infant should start sucking his thumb, and efforts are made by purely restrictive means to prevent him from doing so, attention is immediately focussed upon the act by the opposition encountered, and renewed efforts will be made to overcome the opposition. This will not only fail to stop the act, but instead it will become fixed more strongly than ever. If the infant has discovered his thumb with his mouth, and by sucking it he can help to satisfy a powerful, deep-seated and hitherto unsatisfied or partially satisfied instinct, then efforts to obstruct him will only stimulate him to persevere in his effort to overcome the obstruction. To try and dam back a strong instinctive urge because some of its manifestations are deemed to be undesirable is like trying to dam back a river because some of the land through which it flows is wanted for other purposes. If the river is pursuing an undesirable course, then obviously the thing to do is to provide an alternative channel and to divert the stream into a new channel and away from the old one; and if an instinctive urge cannot be fully satisfied by the means innately intended for it and is finding satisfaction by means of undesirable acts, then alternative acts of a desirable nature must be provided and the stream of instinctive energy diverted in the direction of the new acts and away from the old ones.

"The evidence produced is conclusive that the sucking process is an instinctive act having roots deep in the human organism. It is a stream of energy which must be satisfied and there can be little doubt that thumb-sucking in the human infant, like ear- and lip-sucking amongst calves, is a symptom of an underlying maladjustment, a symptom of an unsatisfied, or partly satisfied, instinctive urge. The new-born human infant finds food, security and comfort in its mother's arms, and its first and most urgent need is to satisfy the sucking instinct by means of which it can obtain food and nourishment. The human infant, unlike most animals, is completely and utterly dependent upon its mother or mother substitute for a considerable time after birth. Although there are many cases on record where children have, of necessity, been weaned from their mothers much earlier than the normal weaning time and have shown satisfactory physical growth, and have not turned to any substitute sucking such as thumb- or finger-sucking, yet my statistics show that this substitute thumb-sucking is more prevalent amongst artificially fed children than breast fed children. The difference is not as great as one would expect at first glance and the explanation, of course, lies in the fact that most babies that are weaned early or have the mother's milk complemented with bottle feeding are treated thus because they cannot, for various reasons, be fully satisfied at the breast. The change-over in these cases, therefore, to full or partial bottle feeding, is designed to restore the feeding routine to a proper balance and to ensure as nearly as possible that the baby's instincts are fully satisfied. In such cases, the change would tend to prevent thumb-sucking rather than encourage it. The greatest care and the closest attention to detail, though, is necessary if the artificially fed child is to remain in perfect adjustment with his environment. For instance, if his food is carefully prepared both as to quality and quantity; if his feeding bottle and utensils are thoroughly sterilized; if the feeding teat is such that he will feed neither too quickly nor too slowly; if his mother nurses him just as she would if she were feeding him at the breast; if she remains quiet and relaxed and the whole

environment is calm and peaceful, then artificial feeding may approach very closely to the conditions of an ideal breast feeding. In such circumstances, it is possible for most infants to satisfy their instinctive requirements. If on the other hand, despite the provision of the correct amount and quality of food, various requirements are neglected; if, for instance, instead of being nursed in the arms of his mother or mother-substitute, he is left in his cot with his bottle propped up on a pillow; if at feeding time there is noise, distraction and tension and, most particularly, if the feeding rate is too quick, then it would be impossible to avoid feelings of frustration and dissatisfaction. The sense of protection, security and comfort would be partly or completely destroyed. The finely adjusted balance of the feeding situation would be upset and variations in behaviour would have to be expected.

"It by no means follows that because an infant is breast-fed he is fully satisfied and well-adjusted to his environment and to his mother; indeed, there are very many breast-fed babies that give evidence of some maladjustment by turning to thumb-sucking. There can be no doubt that the breast-fed baby has a much better chance of having his physical and emotional requirements satisfied than the artificially-fed baby, but it is equally certain that there is still the need for close attention to detail in his feeding technique. It is quite possible for the mother's own milk to be of a quality which is unsuitable for her infant; her nipples may be such as to demand too great an effort from the infant, resulting in feelings of frustration and resentment; her milk may come too easily, thereby requiring insufficient effort on the baby's part. Then, too, she might be nervous, worried and upset by home conditions and these feelings of disturbance are very readily transmitted to the baby. It might be impossible for feeding to take place in a quiet, calm and restful atmosphere and thus, despite the infant's nutritional requirements being satisfied, these various other factors may result in a complete destruction of what might be called the feeding balance. As a result, one would expect to observe behaviour problems, and one of the commonest of these is thumb-sucking. The act of sucking at the mother's breast is the very core of the young infant's existence and with it are linked, as has been shown, strong feelings of comfort, security and protection. If for any reason this central act of sucking becomes unsatisfactory, the infant's feelings of security, comfort and protection are also upset. He will endeavor to satisfy his sucking instinct by turning to a substitute, generally his own thumb or finger, just as the calf, if cheated of its sucking satisfaction, will turn to the ear, teats, tail, etc., of another calf for a substitute. There is no doubt that this substitute thumb-sucking does promote quite strong feelings of security, comfort and protection because of its close association with the genuine feelings of security, comfort and protection experienced whilst sucking at the mother's breast. The important point to realize though is that this substitute sucking is not a *real* satisfaction, and there is no *real* security or comfort or protection associated with it. It is a pure fantasy, and the more it is indulged in, the more is built up a substitute sense of security. The unreality or fantasy associated with it increases until the time comes when the sucking of one's thumb is used as a means of retreat and of escape from unpleasant realities.

"Several writers have observed how some young children aged about 2 to 3 years, whilst busily sucking their thumbs, seem immune to events which under other circumstances promote feelings of fear and distress. The explanation, of course, is that they have retired into their world of fantasy and are no longer affected by the real events happening about them. The whole process is one of conditioning which started when the young infant associated feelings of security so closely with the act of sucking at its mother's breast. When the child is two or three years old, the mother's breast is long forgotten

but the sense of security, albeit a false one, is still promoted by the sucking act and its own finger provides the vehicle.

"Perhaps the most common situation of all though in which young children suck their thumbs is when they are going to sleep and it is the situation in which the persistent thumb-sucker will continue to operate after the practice has been discontinued in all other situations. The original stimulus undergoes a series of modifications to bring this about and the available evidence suggests a chain of events starting when the baby's sucking-feeding instinct is unsatisfied during the normal feeding process and he turns to thumb-sucking as a means of completing this satisfaction.

"A mother should lie down beside her child at sleep time with the idea of providing feelings of comfort and security by her presence; this will be just as much a method in preventing thumb-sucking as it would be to look for a feeding defect. On the other hand, both measures would probably have succeeded if they had been used at earlier appropriate stages. Now further modification has taken place and at the present stage merely to feel tired, or to go to bed, or to feel a piece of ribbon, is itself a strong stimulus to the thumb-sucking act.

"A few children turn to thumb-sucking at weaning time after a normal nine or ten months breast feeding and this fact, too, points to the need for great care and skill in guiding the infant through, what is to him, something of an upheaval. For him to start thumb-sucking at that stage is to take a serious step backward. It is a reversion to an infantile practice and every effort should be made to find the cause and correct it. The sucking urge should now be left behind, and he should move forward, not backward. If the weaning period has passed without any signs of the infant turning to thumb-sucking it is very probable that he will never do so, and therefore the importance of so ordering his existence that this troublesome practice never starts can scarcely be over-estimated. Even after weaning, there is still the possibility of a reversion to this infantile practice, and careless handling on the part of his parents, or severe emotional distress can lead the infant to turn for security and comfort to that fantasy world which is called into being through the act of sucking, and the ever present thumb is the vehicle used. Once thumb-sucking continues after the weaning period, and more particularly if it starts after that period, it can be an extremely troublesome practice to stop.

"Sometimes, too, after the arrival of a new baby the thumb-sucking on the part of the older child is an attempt to regress to an infantile state in which he was entirely dependent on his parents and enjoyed their whole attention.

"Once the practice is started it easily develops into a habit because it is strongly reminiscent of the comfort, security and pleasure experienced as an infant in the mother's arms. These same feelings are stirred again in fantasy and, once awakened, it is all too easy to turn again and again to this fantasy world, especially in times of stress.

"In my opinion, there are two sound reasons why splinting of the arms as a means of correcting the thumb-sucking habit should never be used under any circumstances. Firstly, such a practice violates accepted psychological principles and is capable of causing extremely harmful and lasting effects on the child's personality; and secondly, the evidence obtained from my investigation of over 2,000 children and the 45 case histories shows that such obstructive methods almost invariably fail to achieve their objective.

"My own early attempts at treatment were completely unsuccessful and I firmly believe that it is quite impossible to do as is suggested and keep the child in ignorance of the purpose of the appliance. The mere appearance

of it will at once excite interest and curiosity and some explanation will be needed. Unless the child really has a sore thumb which needs protecting, then the true explanation must be given, or lying resorted to, and to deliberately lie to a child is such a thoroughly undesirable practice that it is not worth serious consideration. The desire to avoid implanting in the child's mind any thought of obstruction or repression in connection with its thumb-sucking is sound, but the avoidance must be real, and the subterfuges suggested are too transparent to stand any chance of success. The claim that the thumbguard has been completely successful in two cases cannot be admitted without further information. If the correction of the thumb-sucking has been achieved at the cost of mental disturbance on the child's part or at the cost of developing an even more undesirable habit, then the cost has been too high.

"The thumbguard should be used with the full understanding and cooperation of the child and that would mean not before the age of 4 years.

"Instead of regarding thumb-sucking merely as a potential cause of malocclusion, it should be regarded as a symptom of some underlying maladjustment. Of importance, too, is the necessity for recognizing the child as an individual possessing certain very definite rights of his own. He is not a machine which one is entitled to obstruct or push around in order to save worry or expense. His individual personality must be respected and in no circumstances is it permissible for parent, doctor, dentist or teacher to impose his or her will on the child merely to serve his or her own interests or convenience. On the other hand, of course, discipline which recognizes the child's individuality and which is exercised in a proper manner is both desirable and necessary.

"The parents of a child who sucks his thumb will often obtain their first professional advice about the habit when they take the child to the dentist, because they are fearful of possible malformation of his jaws. This being so, a serious responsibility rests on the dentist, and great opportunity also, to see that the advice which he gives and the treatment which he prescribes, are based on sound scientific principles and designed to enable the patient to lead a fuller, healthier and happier life. If, in his efforts to safeguard the formation of his patient's jaws, the dentist upsets the smooth working of his mental processes, and particularly if he should do so in such a way as to harm permanently the child's psychological development, then whatever the result of the purely dental treatment, the end results, in terms of the patient's happiness and well-being, have been harmful and retrograde. In order to avoid this the dentist must know something of child psychology, the psychologist must appreciate the dental problem and both must cooperate to the full.

"The main emphasis of treatment should be on prevention, and this must be initiated long before the age at which the dentist normally first comes into contact with his young patients, and must therefore be the responsibility of pediatricians, nurses, kindergarteners and above all parents.

"In the first place, it is necessary to assure those people who are looking for a quick, easy method of 'curing the habit,' that no such 'cure' exists. Thumb-sucking is not a disease to be cured, but a symptom of a maladjustment, the correction of which requires considerable patience, perseverance, skillful handling and self-discipline on the part of those whose responsibility it is to handle it. Two principles apply to this problem at any age. The first is that if the conditions which caused the onset of the act in the first place can be diagnosed and corrected before it acquires the characteristics of a habit with a drive of its own, it will very soon be dropped without any further action being taken.

"If on the other hand the original cause is not soon diagnosed and corrected, and the act does become fixed as a habit, then the second principle applies which calls for a re-direction of the stream of energy behind the act into some other

more desirable form of activity. How this re-direction is to be achieved will vary at different ages. In the first six months when sucking either at the breast or the bottle is the only means by which the infant gets its food, it is very doubtful whether any efforts of re-direction are necessary. Sucking is a perfectly normal instinctive activity at this age which will continue to express itself, in one way or another, till it is satisfied. If it should express itself in the form of thumb-sucking, then it would indicate that it had not been completely satisfied during the feeding process and steps should be taken to diagnose and correct the faults which have developed. There is little doubt that, if this can be done, the thumb-sucking will cease in almost every case.

"The use of mittens is really an obstructive measure which it would be much better not to use and certainly their use could never be justified except when feeding and environmental conditions were perfectly satisfactory. As it would be very difficult to be always certain of this, other means of discouraging the thumb-sucking should be used. Dr. Young's observation is extremely valuable though, and indicates that it is easy to turn the infant's attention away from his thumb, provided the feeding routine is perfectly balanced. Instead of using mittens therefore, the same object would almost certainly be achieved by wrapping the baby in such a way that he experiences some difficulty in getting his hands to his mouth. The method has the great advantage over mittens that, if the baby urgently needs to get his hand free to suck his thumb, he can do so, and furthermore, if this happens, then it is also evidence that there is probably a fault in the feeding routine which needs correction. Without such correction first, neither mittens nor wrapping will do the slightest good.

"Sucking is an activity which is appropriate to the infant's first nine months of life and the appearance of substitute sucking in the form of thumb-sucking or finger-sucking must be regarded as a disturbance or frustration, in some way or another, of the natural sucking-feeding instinct. Clinical evidence shows that one of the commonest ways in which the sucking-feeding instinct remains unsatisfied is when the mother has a very rapid and free flow of breast milk. The infant under these conditions can often satisfy his hunger and nutritional requirements in a very short time, and with a minimum of sucking activity. The instinctive sucking act in the infant possesses a certain measure of intensity and if this instinctive demand is repeatedly denied full satisfaction, then, bearing in mind the way in which an instinct operates, some other means of obtaining satisfaction will be sought, and the thumb or finger provided the most convenient vehicle.

"The aim should be always to keep the feeding routine in proper balance. Nutritional, sucking and emotional requirements all have a place in maintaining this balance and the frustration of any one will cause an imbalance which will, in a certain number of cases, result in substitute sucking. During the first six months of life the human infant is entirely dependent on the sucking act to obtain his food and consequently any appearance of thumb-sucking should immediately suggest a disturbance of the feeding routine, and of the sucking act in particular. A too rapid and too free flow of milk from the breast or bottle is a very common cause of thumb-sucking because it leaves the instinct to suck unsatisfied.

"At about six months, the first teeth erupt, solids begin to appear in the diet, and the gradual transition begins from the stage of development in which the sucking act is appropriate to the next stage of development in which the act of chewing is appropriate and, from this time onwards, if the child is a thumb-sucker, the principal method of treatment should be to provide increasing re-direction of energy away from sucking activities and towards chewing activities. One way in which this can be done is by gently removing the baby's hand from his mouth and *immediately* placing something attractive and chew-

able in his hand, such as a rusk, a brightly colored peg, teething ring, rattle, etc. This must be done with great gentleness and friendliness in the nature of a game. Just to remove the hand from the mouth and nothing more, however gently it is done, is doomed to failure because it would be a purely obstructive act. On the other hand to remove the thumb which is being sucked and immediately replace it with a chewable object is to re-direct the energy from one form of activity into another, from a sucking act to a chewing act, from a form of activity which is appropriate to a developmental stage which is gradually being left behind and towards an act which is appropriate to the next developmental stage. Great patience and perseverance is required to carry this out successfully.

"Even within the first nine months the sucking-feeding instinct undergoes 'complication and modification' because several case histories record the fact that the baby has started thumb-sucking within the first month or two and at 7-8 months is still thumb-sucking *but only when tired or going to sleep*. This now has little, if anything, to do with any defect in the feeding routine which might have been the original cause of the thumb-sucking, but the need now is for a sense of comfort and security, and substitute sucking promotes these feelings. Under these circumstances the correction of the original maladjustment, if it is still present, is necessary, but this correction will be insufficient to bring about a cessation of the thumb-sucking, and re-direction of the sucking activity into chewing activity is indicated.

"Close attention must be paid to satisfying the baby's widening sphere of interests as he grows older. For instance, suitable toys such as rattles, rings, coloured beads, etc., should be provided with which he can practice movements with his hands and eyes as his sleeping hours decrease, and care must be taken to provide him with more companionship so that he will not be left alone for long periods of time in his pram with nothing to do. It is then that he would tend to be thrown back upon himself and would find it easy to turn to thumb-sucking instead of having his attention directed outwards. If the necessary precautions and careful planning are carried out, the infant's horizon will widen quite naturally and infantile acts will drop away as he grows older.

"The principle is similar to that involved in wrapping the very young baby up closely, so as to present some difficulty to its getting its hand to its mouth.

"If there is an urgent need to suck, no close wrapping or attractive toys will deflect the infant's attention from his thumb but if the feeding balance and general environment are satisfactory, attention can easily be deflected from the thumb.

"If now the baby's feeding and general environment are well-adjusted it is probable that his substitute sucking, as it might be called, will very soon be given up, or better still—never started. The important point is that it will be given up before the act becomes set into a habit. The older the infant becomes with the conditions giving rise to the thumb- or finger-sucking uncorrected, then the more studied, the more set and the more selective the act becomes, until by the age of two years, if still persisted in, he will almost certainly suck only one particular thumb or finger of one particular hand, and with one particular technique. By this time it has become a most difficult psychological problem.

"The primary aim should be to prevent the habit from developing, and to this end, if observations reveal that thumb- or finger-sucking is indulged in, then that should be the signal to examine immediately all feeding and other environmental conditions in order to discover and correct the underlying maladjustment.

"Immediate post-weaning period is probably the most difficult time to handle the thumb-sucker. There is no convenient instrument to use for his

re-direction; he is not yet old enough for explanations or reasoning; consequently, we cannot look for any self-help from him. He should, by now, have dropped his sucking impulses and their place should be taken by biting impulses. His teeth are starting to erupt and this does offer a most hopeful means of encouraging his natural transition from the one stage, which is characterized by sucking activities, to the next stage which is characterized by biting activities. Every encouragement, therefore, should be given for the development of his chewing and biting tendencies. Mothercraft books stress the need for introducing such things as rusks, toast crusts, and food requiring chewing, and these techniques should be carefully followed, not only in the interests of stimulating the healthy growth of jaws and teeth, but also because it directs attention and energy towards an act which is consistent with the present stage of development, and away from the previous, outgrown act of sucking. Suitable sterilized rubber rings can also be provided to stimulate chewing, and if the tendency is noticed for a continuation of sucking in the form of thumb- or finger-sucking, then there is need for an extra effort on the mother's part to check this tendency.

"Understanding the problem, the mother will, of course, keep completely calm and prevent, at all costs, undue attention being directed to the act either by herself, her husband, or relations and friends. Fuss or obstruction or tension at this time will surely be transmitted to the child. She should give him as much company during his waking periods as she can. She should provide him with suitable toys appropriate for his age and should try to arouse changes with these so as to maintain his interest, leaving him alone as little as possible when he might be awake with nothing to do.

"The feeling of insecurity when meeting new people and facing new situations, too, will often cause the infant to turn to the pseudo-security provided by sucking his thumb. The mother can often help her infant over such periods by quite unobtrusively holding his hand or standing by him, and thus providing him with a real sense of security.

"When children go to kindergarten at the age of two, to two and a half, they are very nearly of an age, and some actually are of an age, when they can be approached through reasoning.

"The approach to kindergarten children is to induce in them a desire to stop sucking their thumbs; and having achieved this, to give them some specific means of re-directing the thumb-sucking into some closely related but more desirable form of activity. Visual education seems to offer the most likely means of success and probably the production of suitable photographs, of careful but simple explanations of how thumb-sucking will spoil their teeth and make them look peculiar, will help to plant the initial desire. If the child has already caused any ill-effects to his own teeth by his thumb-sucking, these can be demonstrated by means of a mirror. It cannot be stressed too strongly, of course, that this means of approach must be made alone and not in front of other adults, and it must be made in the friendliest possible way without the slightest hint of censure or reproof. It is important, also, that some new and more desirable form of activity which will appeal to the child must be available immediately. One means of re-direction of the sucking urge, which can be used either by itself or in conjunction with the simple explanations suggested, is to encourage the use of chewing gum, and to encourage as much as possible the use of hands in some activity such as games requiring the handling of toys or tools. Chewing gum seems to correspond, in its use at this age, to the use of the dummy in the pre-weaning period. It has the great advantage that it exercises the muscles of mastication and stimulates healthy growth. It provides very little sugar and is unlikely to damage the teeth and it is certain that it would be impossible to suck the thumb and chew gum at the same time. Objections may be raised that it is undesirable from an esthetic point of view, but there seems to be so much in

favor of its use, particularly with the child who is a persistent thumb-sucker, that these objections must be set aside.

"The children are most likely to revert to thumb-sucking when listening to stories or when they are fantasy building, when they are idle or bored, or when going to sleep. During the first two situations they could easily be encouraged to chew gum and they would probably welcome the chance. Their sleep period, however, presents a difficulty, for it would be unwise to let them have chewing gum at that time. It might be possible to overcome this by always giving them a slice of apple to eat when they lie down, or by having the child's mother or mother-substitute sit by the cot, and perhaps hold a hand whilst he goes to sleep. The idea would be to provide that sense of security which the child might need and to provide it in reality instead of in fantasy, which is all that thumb-sucking does.

"If thumb-sucking is still indulged in after five years of age, it has probably become firmly rooted in the child's make-up by faulty handling on the part of parents and friends. At this stage there is usually little difficulty in discussing the matter quite openly with the child himself. Once again though great care must be taken to avoid any suggestion of censure or reproof. If he is taken carefully he will probably admit that he would like to give it up and, with the crystallization of his desire in this regard, a big step towards breaking the habit has been achieved. Once he realizes that one's desire is to help and encourage him to achieve something which he wants to do, he will usually cooperate very readily in any means suggested. He can usually be easily informed and convinced of the need for breaking the habit and, with the establishment of an atmosphere of friendliness and encouragement, there remains only the need for providing him with the means of re-directing what has now become an extremely deep-rooted and powerful urge. The initial favorable atmosphere is all important, but this alone will not be sufficient for, however much the child might want to conquer the habit, he should always be provided with some other more desirable form of activity into which his thumb-sucking energies can be re-directed. If this is not done, he will either forcibly repress his desire to suck his thumb with resulting mental disturbance later on, or he will give up his thumb-sucking and regress still further to some such habit as nail-biting.

"In the case of the older children, the whole secret of success is in bringing out in the child himself the desire to break the habit, in building up his morale with kindness and encouragement and with providing practical specific means for re-directing his energies.

"Parent education is a *sine qua non* for the successful guidance of the growing child so that he will be properly adapted at the various stages of his development and so that he will live through the experiences which are characteristic of the various ages through which he passes. In this way he will, as he leaves infancy behind, naturally outgrow infantile habits and practices; and one of these, of course, will be the infantile practice of sucking.

"A broad principle which should be recognized at this stage is that the thumb-sucking involves no moral issue. There is no question of it involving either 'naughtiness' or 'goodness,' and, consequently, in handling it there should be no question of using anything which savours in the least of punishment. It would be wrong, too, to force an issue of obedience in connection with the act, such as ordering the child to refrain from sucking his thumb and expecting unquestioning compliance with such an order.

"It is generally recognized that fear of whippings and severe punishment will have evil effects, but it should be clearly realized, also, that fear of nagging and harsh criticism may be just as harmful and paralysing to the sensitive child.

"No obstruction or punishment should be used in the handling of thumb-sucking, but patience, friendliness and careful re-direction of the urge."

News and Notes

Excerpt From Minutes of American Association of Orthodontists

An excerpt from the report by Dr. Joseph D. Eby, Chairman of the Editorial and Publication Committee, made to the Board of Directors of the American Association of Orthodontists, April 22, 1951, at Louisville, Ky., follows.

It has been thought for several years that inasmuch as the expense of illustrations has almost quadrupled, chairmen of program committees should be provided with a copy of the excerpt from the report. This would enable the chairmen to apprise a prospective essayist on the matter of illustrations in advance of his accepting the invitation to participate in the program.

It is thought that by this policy much of the disappointment caused by being unable to publish myriads of illustrations in the JOURNAL would be eliminated.—*Ed.*

EXCERPT FROM MINUTES OF A. A. O., APRIL 22, 1951, IN REGARD TO ILLUSTRATIONS

It is therefore recommended that the A. A. O. issue official instructions to all Presidents, Executive and Program Committees in order that essayists and authors, as far as practical, shall prepare their manuscripts and illustrations as uniformly as possible for publication. It is recommended that such instructions should direct that a written manuscript be accompanied by the minimal number of illustrations sufficient to portray the substance of the text to the reader. Attention may then be called to the fact that an essayist could ad lib all he wanted with illustrations upon presentation, without throwing a superfluous and extensive load of illustrations into the literature.*

Tufts Graduate Orthodontic Study Club

Tufts Graduate Orthodontic Study Club held a meeting program Sunday, March 23, 1952, at the Harvard Club, Boston, Mass.

Subject: Seminar on the Treatment of Class II, Division 1 malocclusion.

Review of the literature of Class II, Division 1

Henry Kaplan. Prior to 1900.
Everett Shapiro. 1900 to 1910.
Murray Bernstein. 1910 to 1920.
Sue Rothenberg. 1920 to 1930.
Edward Gilda. 1931 to 1940.
Norman Cetlin. 1940 to 1952.
Herbert I. Margolis. Summary.

Case presentation of Class II, Division 1 cases and problem cases by the members.
Also there was a table clinic of treated cases by all members of the Study Club.
General Discussion of cases by all members.

European Orthodontic Society

The twenty-ninth annual congress will take place at Scheveningen from July 14 to 17, 1952, in the Kurhaus-Hotel, the center of the largest seaside resort of the Netherlands.

*Authors who insist on a number of illustrations in excess of the budget set up by the American Association of Orthodontists are permitted to pay for such excess personally.

Denver Summer Seminar for Advanced Study of Orthodontics

The Denver Summer Seminar will be held this year at the Park Lane Hotel, Denver, Colo., Aug. 3 through 8, 1952.

Dr. Isaac Schour, of the Department of Histology, University of Illinois College of Dentistry, will title his presentation, "The Biology and Physiology of the Supporting Structures of the Teeth."

Hermann Becks, M.D., D.D.S., with the George Williams Hooper Foundation, University of California, will lead discussion on "The Old Problem of Root Resorption"; "The Role of the Pituitary in Bone Growth and Development"; and "Can We Prevent or Control Dental Caries?"

Dr. Harvey Stallard, of San Diego, Calif., will have as his subject "How to Adjust Teeth Orthodontically to the Fixed Factors of Articulation."

Dr. S. D. Gore, of New Orleans, La., will present "The Technique of Fabrication and Treatment With the 'Crozat' Appliance." Dr. Archie B. Brusse and Dr. William R. Humphrey, of Denver, Colo., will follow this presentation with "Technique of Fabrication of the 'Crozat' Appliance with Chrome Alloy."

Mexican Orthodontists Elect Officers for 1952-1953

The Mexican Association of Orthodontists (Asociacion Mexicana de Ortodoncia) recently announced its newly elected officers for 1952-1953. They are: Rutilio S. Blanco, President, Roberto M. Ruff, Secretary, and Margarita Correa, Treasurer.

Orthodontics in Public Health

A panel on the public health aspect of orthodontics was conducted in Washington on March 10 and 11 by the Children's Bureau under the direction of Dr. John T. Fulton. Methods for the measurement of malocclusion were discussed in detail. Those participating were Drs. J. A. Salzmann, of New York, Robert Ricketts, of Chicago, Wendell L. Wylie, of San Francisco, Helmuth Zander, of Minneapolis, Robert Meyers, of Toronto, Canada. The Public Health Service was represented by Drs. Walter J. Pelton, John W. Knutson, and William A. Elsasser.

Labiolingual Postgraduate Course

The fourth annual two-week postgraduate orthodontic course under the direction of Dr. Oren A. Oliver was held Feb. 18 through March 1, 1952, at Washington University, School of Dentistry, St. Louis, Mo. Dr. Oliver was assisted by Dr. Boyd W. Tarpley, Birmingham, Ala., Dr. Harold Terry, Miami, Fla., and Dr. William H. Oliver, Nashville, Tenn.

Concentrated study of the construction and clinical application of the occlusal guide plane was presented.

Of special interest was the research result of the use of the guide plane as presented by Dr. Terry and Dr. William S. Brandhorst of St. Louis. They presented laminographic and cephalometric evidence that usually within one month after the insertion of the guide plane the condyle returns to its normal position in the glenoid fossa although the occlusion remains in corrected position and deep overbites are corrected.

Admiral Ryan Named New Chief of Navy Dental Division

Rear Admiral Daniel W. Ryan, 9th Naval District Dental Officer (Great Lakes, Ill.), assumed the position of chief of the Navy Dental Division and assistant chief of the Bureau of Medicine and Surgery on Monday, Feb. 18, 1952, the Navy Department has announced. Rear Admiral A. W. Chandler, Inspector General of the Dental Division, was temporarily

assigned these duties after the retirement of Rear Admiral Spry O. Claytor on January 1. Admiral Ryan has held his present position since August, 1950. He served with the Army during World War I, and two years after his graduation from the University of Denver, School of Dentistry, in 1923, he joined the Navy. Rear Admiral Alfred R. Harris will be the new dental officer for the 9th Naval district and Captain James Purcell will succeed Admiral Harris as 14th Naval district dental officer (Pearl Harbor). At the same time, the Navy announced the retirement of Rear Admiral Robert S. Davis, former chief of the Navy Dental Division, after thirty-four years of active duty. Prior to his retirement, Admiral Davis was 12th Naval district officer (San Francisco).

**Dr. Herbert K. Cooper, Guest Lecturer, Spoke at
National Naval Medical Center**

The sixth of the 1951-1952 series of guest lectures, sponsored by the Commanding Officer of the Naval Medical School, National Naval Medical Center, Bethesda, Md., was held at 8:15 P.M., Friday, March 28, in the auditorium at the Center.

The guest speaker was Herbert K. Cooper, D.D.S., Director, Lancaster Cleft Palate Clinic, Inc., Lancaster, Pa. He spoke on "The Integration of Services Necessary in the Rehabilitation of Cleft Palate Patients." Cleft palates and cleft lips are one of the most frequently found congenital conditions known today. Excepting surgery, all other services necessary in the handling of the cleft palate individual have received very little attention. Integration of all services is important in the treatment of a total person rather than a part of him. A discussion will be given in the handling of the handicapped individual.

Dr. Cooper is the founder and director of the Lancaster Cleft Palate Clinic, Inc., and Member, Medical Advisory Board, Commonwealth of Pennsylvania.

Notes of Interest

Dr. Maxwell S. Fogel announces the association of Dr. Jack Magill for the exclusive practice of orthodontics at Suite 303, Central Medical Bldg., Philadelphia, Pa.

John A. Kaciewicz, D.M.D., announces the opening of his office at 707 Union Trust Bldg., Providence, R. I., practice limited to orthodontics.

Barnett Malbin, D.D.S., announces the removal of his offices to 717-721 David Whitney Bldg., Detroit, Mich., practice limited to orthodontics.

Benjamin L. Spector, D.D.S., announces the opening of offices at 99 Pratt St., Hartford, Conn., practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES

THE AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

American Association of Orthodontists

President, Bernard G. deVries - - - - - 705 Medical Arts Bldg., Minneapolis, Minn.
President-Elect, Brooks Bell - - - - - 4150 Mockingbird Lane, Dallas, Texas
Vice-President, Malcolm R. Chipman - - - 1251 Medical Dental Bldg., Spokane, Wash.
Secretary-Treasurer, George R. Moore - - - - - 919 Oakland Ave., Ann Arbor, Mich.

Central Section of the American Association of Orthodontists

President, Paul G. Ludwick - - - - - Sharp Bldg., Lincoln, Neb.
Secretary-Treasurer, Frederick B. Lehman - - - - - Merchants National Bank Bldg.,
 Cedar Rapids, Iowa

Great Lakes Society of Orthodontists

President, Holly Halderson - - - - - Medical Arts Bldg., Toronto, Ontario, Canada
Secretary-Treasurer, Carl R. Anderson - - - - 402 Loraine Bldg., Grand Rapids, Mich.

Middle Atlantic Society of Orthodontists

President, George M. Anderson - - - - - 831 Park Ave., Baltimore, Md.
Secretary-Treasurer, Gerard A. Devlin - - - - - 49 Bleeker St., Newark, N. J.

Northeastern Society of Orthodontists

President, Paul Hoffman - - - - - 1835 Eye St., N.W., Washington, D. C.
Secretary-Treasurer, Oscar Jacobson - - - - - 35 W. 81st St., New York, N. Y.

Pacific Coast Society of Orthodontists

President, Reuben L. Blake - - - - - 240 Stockton St., San Francisco, Calif.
Secretary-Treasurer, Frederick T. West - - - - 760 Market St., San Francisco, Calif.

Rocky Mountain Society of Orthodontists

President, Curtis E. Burson - - - - - 1232 Republic Bldg., Denver, Colo.
Vice-President, Kenneth R. Johnson - - - 311 E. Pikes Peak Ave., Colorado Springs, Colo.
Secretary-Treasurer, Don V. Benkendorf - - - - 932 Metropolitan Bldg., Denver, Colo.

Southern Society of Orthodontists

President, Walter T. McFall - - - - - Flatiron Bldg., Asheville, N. C.
Secretary-Treasurer, Frank P. Bowyer - - - - - Medical Arts Bldg., Knoxville, Tenn.

Southwestern Society of Orthodontists

President, Dan C. Peavy - - - - - 745 Milam Bldg., San Antonio, Texas
Secretary-Treasurer, Fred A. Boyd - - - - - 1502 North Third St., Abilene, Texas

American Board of Orthodontics

President, Stephen C. Hopkins - - - - - 1746 K St., N. W., Washington, D. C.
Vice-President, Leuman Waugh - - - - - 931 Fifth Ave., New York, N. Y.
Secretary, C. Edward Martinek - - - - - 661 Fisher Bldg., Detroit, Mich.
Treasurer, Reuben E. Olson - - - - - 712 Bitting Bldg., Wichita, Kan.
Director, Raymond L. Webster - - - - - 133 Waterman St., Providence, R. I.
Director, Ernest L. Johnson - - - - - 450 Sutter St., San Francisco, Calif.
Director, Lowrie J. Porter - - - - - 41 East 57th St., New York, N. Y.

There is an apparent discrepan

The pages are either missing or

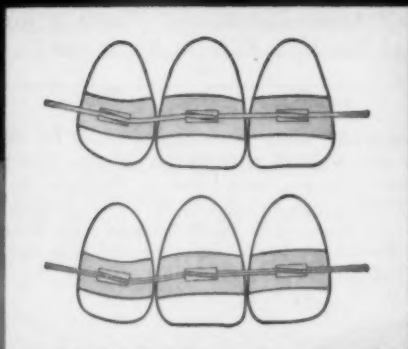
The filming is recorded as the

ncy at this point.

or the pagination is incorrect.

e book is found in the collections.

SINGLE WIRE SWIRLOK



TWIN-WIRE SWIRLOK



Design suggested by Dr. A. Sved

Swirllok
TRADE MARK

SELF-LOCKING BRACKETS

SINGLE AND TWIN-WIRES LOCKED WITHOUT TIEING...

With Swirllok, you slip the wire or wires through the bracket and they're "locked" in place. No more tieing, lost caps or rotating loops. They are most comfortable for the patient because they're streamlined for minimum bulk, without sharp edges.

Supplied in platinum-color high-fusing hard precious metal mounted on Aderer Temperable Band Strips or Dr. Downs' design contoured bands. Available in 2 lengths, 0.100" (narrow) and 0.125" (wide).

ADERER GOLDS

Julius Aderer, Inc., New York · Chicago

219 East 44th Street
New York City

55 East Washington Street
Chicago

IT WAS A BRIGHT EARLY DECEMBER DAY and Lieutenant Hudner was flying a Korean combat mission alongside another plane piloted by Ensign Jesse Brown. A burst of flak caught the ensign's plane and he went spinning down,



afire. Despite the presence of enemy ground troops, Lieutenant Hudner then deliberately crash landed near his flame-trapped shipmate. He radioed for help, after which he fought to keep the fire away from the fatally injured ensign until a rescue helicopter arrived. Today Lieutenant Hudner has something to say to you:

"Maybe if America had been strong enough to discourage aggression two years ago, my friend, Jesse Brown, might be alive right now.

So might thousands more of our Korea dead.

"For it's only too sadly true—today, in our world, weakness invites attack. And *peace is only for the strong*.

"Our present armed forces *are* strong—and growing stronger. But don't turn back the clock! Do your part toward *keeping* America's guard up by buying more . . . and more . . . and more United States Defense Bonds *now*! Back us up. And *together* we'll build the strong peace that all Americans desire!" *Peace is for the strong! Buy U. S. Defense Bonds now!*

★ ★ ★

Remember that when you're buying bonds for defense, you're also building a reserve of savings. Remember, too, that if you don't save *regularly*, you generally don't save at all. So sign up today in the Payroll Savings Plan where you work, or the Bond-A-Month Plan where you bank. For your country's security, and your own, buy U. S. Defense Bonds now!

Lieutenant (jg)
Thomas Hudner, Jr.
U.S.N.



Medal
of Honor



The U. S. Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers of America.

ORTHODONTIST—Three (3) room office available, laboratory, dark room, excellent Parkchester—Bronx, N.Y., location. Concentrated population. Professional street. Share waiting room with established physician. Orthodontist much in demand. Phone TA 9-7115, Bronx, N.Y.

ORTHODONTIST WANTED IN N. J.

Associate in busy practice. Fine clientele. Opportunity to buy interest or entire practice. Will stay with qualified man 3 to 6 years. Must submit full details: age, training, references, experience, etc. Answers confidential. Address Box WB, Amer. Jour. of Orthodontics, 3207 Washington, St. Louis 3, Mo.

Handbook of

PEDIATRIC MEDICAL EMERGENCIES

"This is a valuable quick reference handbook. It should be within easy reach of everyone who has children patients. . . . Although the book is based upon hospital experience, it contains much that should be of value to the general practitioner caring for cases in the home and office. Dr. DeSanctis and his associates have produced a volume which will be widely used and be the means of saving many lives."—GP—September, 1951.

Edited by ADOLPH G. DeSANCTIS, M.D., and CHARLES VARGA, M.D., with 11 other Contributors. 384 pages, 51 illustrations. Price, \$5.00. The C. V. Mosby Co., St. Louis 3, Mo.

Orthodontist wishes to purchase or associate in active practice in New York or New Jersey. For details reply to Box HB, Amer. Jour. of Orthodontics, 3207 Washington Blvd., St. Louis 3, Mo.

A Handsome Permanent Binder for American Journal of Orthodontics



NOTE PRICES
Single Binder
\$3.25 each.
Two or more of
same journal,
\$2.75 each.

The **ONLY** binder that opens flat as a bound book! Made of durable imitation leather, it will preserve your journals permanently. Each cover holds 12 issues, one volume. Do your own binding at home in a few minutes. Instructions easy to follow.

Mail coupon for full information and binder on 10-day free trial.

MAIL COUPON TODAY

SUCKERT LOOSE LEAF COVER CO.
234 W. Larned St., Detroit, Michigan
Mail postpaid _____ binders for "The American Journal of Orthodontics" for year _____. Will remit in 10 days or return bindings collect.

Name _____

Address _____

Publishers Authorized Bindings

12 issues per volume, January to December, inclusive, \$2.75

American Journal of Orthodontics

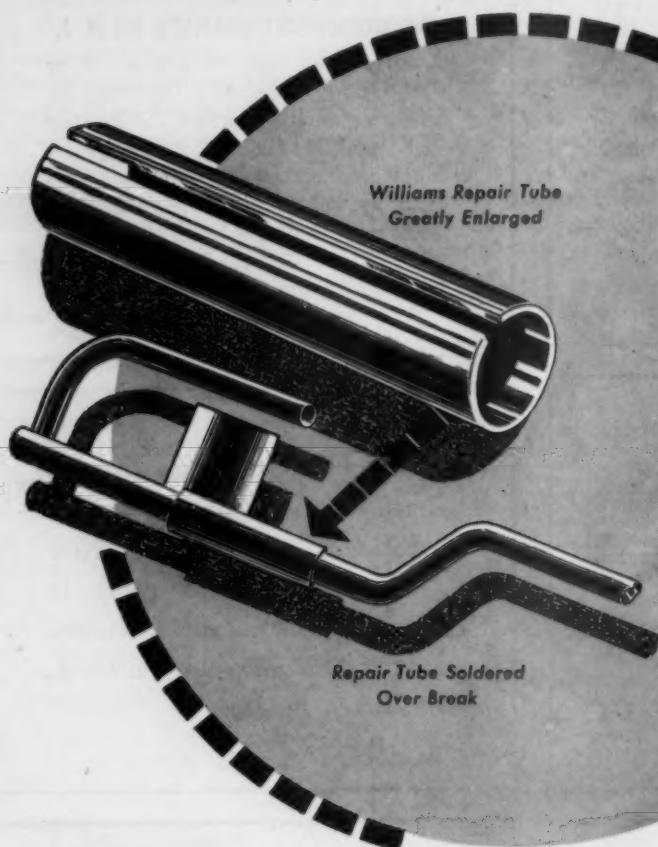
Beautifully Bound in Best Grade Washable Buckram, Your Name on the Front Cover

Special arrangements have been made by THE C. V. MOSBY COMPANY whereby subscribers can have their copies economically bound to the publisher's specifications. You can now have your issues of *American Journal of Orthodontics* bound in best grade of washable buckram with your name imprinted in genuine gold on the front cover. Write for full particulars.

THE BOOK SHOP BINDERY

308 West Randolph Street Chicago 6, Ill.

WILLIAMS Foremost in orthodontic materials



Williams Repair Tube
Greatly Enlarged

Repair Tube Soldered
Over Break

**breaks
in the
lingual arch
quickly
and
simply
mended !**

WILLIAMS

Arch REPAIR TUBES

● Here's a combination of ingenuity and practical technic. No need to construct a new arch wire or attempt a bulky soldering job. For those bothersome breaks in the lingual arch just in front of the half round post, you insert the broken ends of the wire into the slotted repair tube, flow in a little solder . . . the arch is stronger than ever. Williams Repair Tubes are precision made, very thin and accurately slotted to slide past the post. The slot makes it easy to see and fit perfectly the broken ends before soldering. Supplied in four sizes to meet the needs of practically every type of lingual arch construction.

For details write for Williams "Aids to Your Orthodontic Technic," fully illustrated, with convenient ordering chart.

WILLIAMS

BUFFALO 14, N.Y.



Gold Refining Co., INC.

FORT ERIE N., ONT • HAVANA, CUBA



AMERICAN JOURNAL OF ORTHODONTICS

Published by THE C. V. MOSBY COMPANY, 3207 Washington Blvd.
St. Louis 3, U. S. A.

Entered at the Post Office at St. Louis, Mo., as Second-class Matter

Published Monthly, Subscriptions may begin at any time.

Official Publication of The American Association of Orthodontists,
its component societies and The American Board of Orthodontics

Editor-in-Chief

H. C. Pollock

Sectional Editors

Charles R. Baker, Evanston, Ill.
Henry Cossitt, Toledo, Ohio
Joseph D. Eby, New York City
Henry F. Hoffman, Denver, Colo.

James D. McCoy, Beverly Hills, Calif.
Oren A. Oliver, Nashville, Tenn.
William E. Flesher, Oklahoma City, Okla.

Associate Editors

Dentistry for Children
Walter T. McFall, Asheville, N. C.

Abstracts and Reviews
J. A. Salzmänn, New York City

EDITORIAL COMMUNICATIONS

Original Communications.—Manuscripts for publication and correspondence relating to them should be sent to Dr. H. C. Pollock, 8015 Maryland Ave., St. Louis 5, Mo., U. S. A.

Manuscripts should be typewritten on one side of the paper only, with double spacing and liberal margins. References should be placed at the end of the article and should include, in the order given, name of author, title, journal, volume, pages, and year; e.g., Smith, E. J.: Children's Dentistry, *Am. J. Orthodontics*, 34: 1-25, 1947. Illustrations accompanying manuscripts should be numbered, provided with suitable legends, and marked on margin or back with author's name. Articles accepted for publication are subject to editorial revision. Neither the editors nor the publishers accept responsibility for the views and statements of authors as published in their "Original Communications."

Illustrations.—A reasonable number of half-tone illustrations will be reproduced free of cost to the author, but special arrangements must be made with the editor for color plates, elaborate tables, or extra illustrations. Copy for zinc cuts (such as pen drawings and charts) should be drawn and lettered only in India ink, or black typewriter ribbon (when the typewriter is used), as ordinary blue ink or colors will not reproduce. Only good photographic prints or drawings should be supplied for half-tone work.

Books for Review.—Only such books as are considered of interest and value to subscribers will be reviewed, and no published acknowledgment of books received will be made. These should be sent to Dr. J. A. Salzmänn, 654 Madison Ave., New York City.

Reprints.—Reprints of articles published among "Original Communications" must be ordered specifically, in separate communication to the publishers, The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., U. S. A., who will send their schedule of prices. Individual reprints of an article must be obtained through the author.

BUSINESS COMMUNICATIONS

Business Communications.—All communications in regard to advertising, subscriptions, change of address, etc., should be addressed to the publishers, The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo.

Subscription Rates.—Single copies, \$1.10. In the United States and other countries of the U. S. Postal Zone \$10.00 per year in advance. In Canada and other foreign countries \$11.00, single copies \$1.20.

Remittances.—Remittances for subscriptions should be made by check, draft, post-office or express money order, payable to the publishers, The C. V. Mosby Company.

Change of Address.—The publishers should be advised of change of subscriber's address about fifteen days before the date of issue, with both new and old addresses given.

Advertisements.—Only articles of known scientific value will be given space. Forms close first of month preceding date of issue. Advertising rates and page sizes on application.

Bound Volumes.—The Book Shop Bindery, 308 West Randolph Street, Chicago 6, Illinois, will be glad to quote prices for binding complete volumes in permanent buckram.



S.S. White **PRECIOUS METAL WIRES** *for Arches and Springs*

NO. 61 METALBA—Platinum Color

A high-grade, exceptionally strong, tough, springy wire. No. 61 Metalba is the highest grade orthodontic wire of our manufacture. It is high fusing, and maintains its high physical properties after soldering operations.

\$3.90 per dwt.

GOLD PLATINUM—Gold Color

Gold Platinum Wire has been proving its merits for all types of arches and springs for more than a quarter century. It's easy working, strong, tough, springy, and doesn't "tire" or lose its elasticity while orthodontic treatments are in progress.

\$3.00 per dwt.

NO. 12 CLASP

A high grade wire with physical properties that rival closely those of the highest priced orthodontic wires. It's almost as strong as the strongest, moreover, it is very tough and elastic, and an exceptional arch wire.

\$2.80 per dwt.

S. S. WHITE METALBA BRAND BAND MATERIAL

A high-fusing, non-tarnishing all precious metal, medium hard band material, costing little more than base metal products. It's easy working, tough, and has good strength—sufficient for all orthodontic purposes. Metalba Band Material requires no particular heat treatment. It is high fusing and gold solder of any fineness may be used with it.

\$2.40 per dwt.

ALL MADE IN POPULAR GAGES AND WIDTHS

Prices subject to change

THE S. S. WHITE DENTAL, MFG. CO., 211 S. 12th STREET, PHILADELPHIA 5, PA.
